

# MACHINERY

JUNE, 1914

## VIBRATION IN MACHINERY AND ITS ELIMINATION\*

### THE BENEFICIAL EFFECT OF HERRINGBONE GEARS IN RUBBER WORKING

BY WALTER J. BITTERLICH†

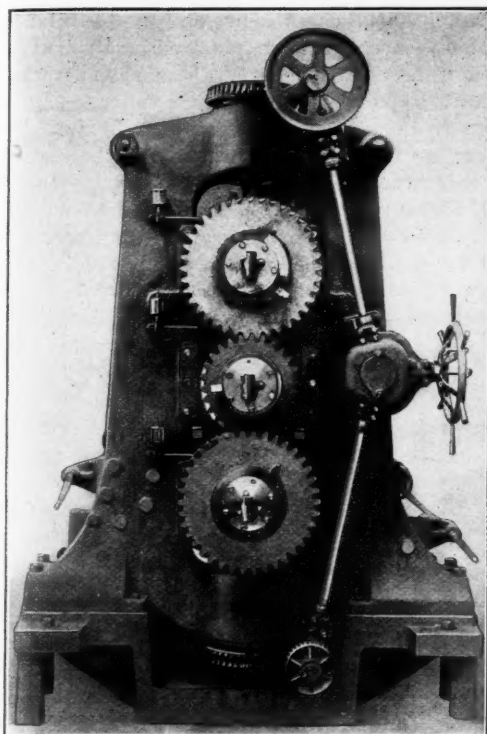


Fig. 1. Housing of Heavy-duty Calender and Roll Pressure Control

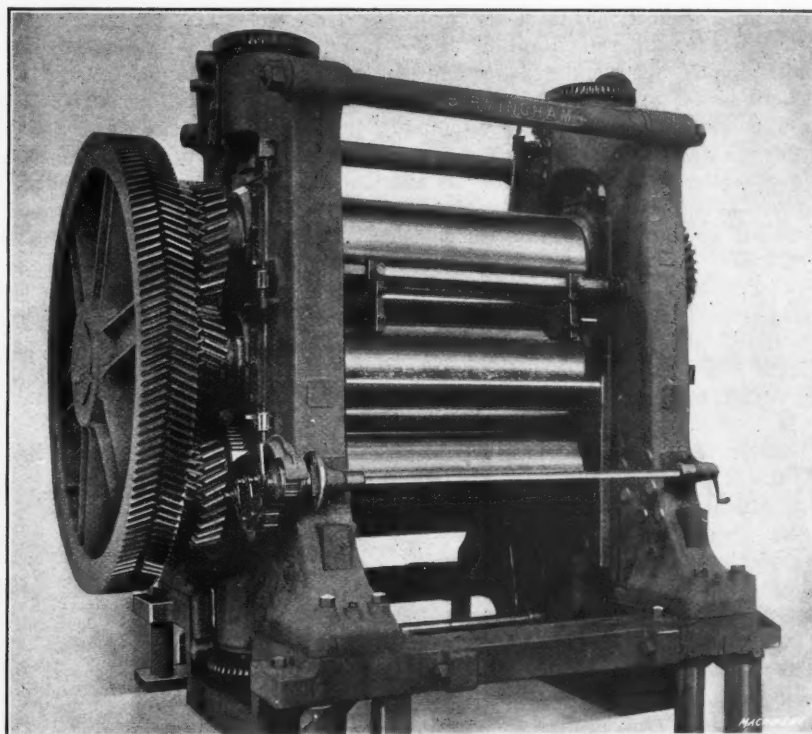


Fig. 2. Heavy-duty Three Roll Calender for Rubber Tire Work, equipped with Herringbone Gears

WERE the average person asked what feature of the mill-room in a rubber factory is the most distressing, he would undoubtedly reply "the odor." But this is not the case, as in the average rubber factory the vibration and noise are by far the most distressing features to be encountered. The sense of smell soon becomes accustomed to the disagreeable odors, while the effect of vibration and noise on the individual tends to increase rather than decrease as time passes. The noise in some departments of large rubber plants is nerve-racking, and at times one can feel the entire building tremble, even though the machinery is mounted on massive foundations, the power required to

masticate the rubber being enormous. There are various sizes of calenders and mills, and the power required varies directly in proportion to the sizes of the rolls, all other conditions being equal. They are in almost all cases worked to their maximum capacity, making the noise very disagreeable.

Noise is produced by vibration, and in rubber machinery equipped with heavy spur gears it is due to the intermittent hammering action of the gear teeth. The use of pinions of rawhide or other soft material has lessened the noise considerably, but even these, when worn, produce noise. Everyone is aware of the effect of noise on operatives; it must naturally reduce their efficiency, decrease the output, and consequently increase the cost of production.

\* See also "Power Transmitted by Herringbone Gears," MACHINERY, June, 1913, and "Herringbone Gears," January, 1912.

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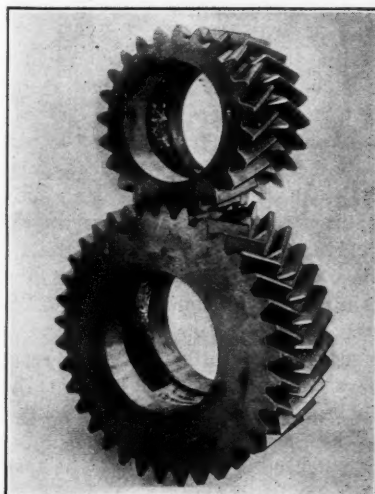


Fig. 3. Special Herringbone Gears

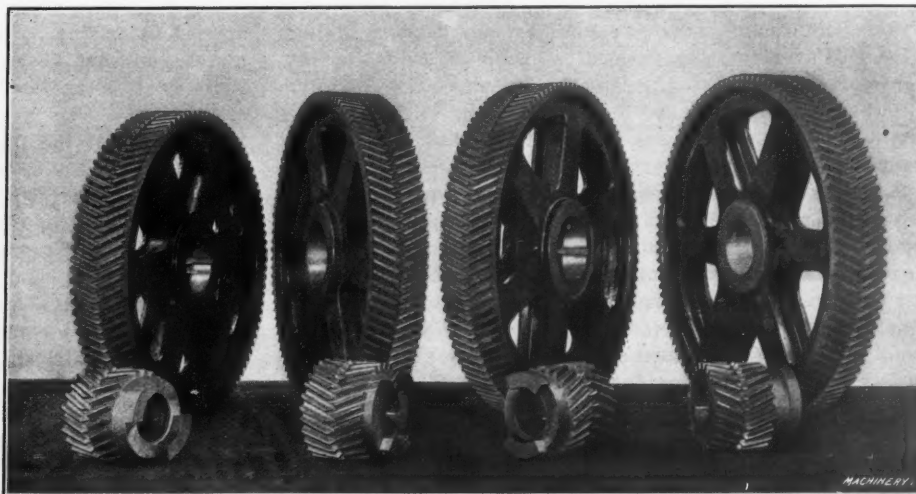


Fig. 4. Group of Wuest Herringbone Gears for Rubber Mills

Noise in buildings of slow burning construction is not so apparent as in the concrete building; this is because the wood of the former construction acts as a shock absorber, while the rigidity of the concrete building tends to enhance the noise. Since the progress of modern building is toward concrete construction, the elimination of noise should be given careful consideration.

The effect of vibration on rubber calenders and mills is detrimental to the life of the machines, as it causes rapid wear in the bearings, throwing them out of alignment and thereby increasing the frictional losses. There are also premature renewals of broken parts due to shocks, and since all the mills and calenders are equipped with steam and water pipe connections, these become leaky from the vibration. To sum up, the vibration causes increased depreciation, and adds to the maintenance and operating costs.

There is no type of chain or gear drive for transmitting heavy power that will entirely eliminate noise, although, by proper design, the noise and vibration can be minimized to a great extent. The best means for eliminating noise is by the use of properly cut herringbone gearing. Herringbone or double helical gears have been developed to such a stage in the last few years that with accurately generated teeth they cause less vibration than any other type of mechanical transmission. The principle that makes for superiority over other types is the smooth, continuous action of the teeth during engagement instead of the intermittent hammering action occurring in nearly every other type of drive. Worm-gear drives have been tried on rubber mills, but owing to their low efficiency when transmitting very high powers even when well designed, they are not a commercial success.

The advantages of the herringbone gear in rubber machinery are as follows:

Greater efficiency (98 and 99 per cent having been obtained in actual practice); noise reduced to a minimum; wear evenly distributed over entire tooth face, which cannot be obtained on straight spur gear teeth; reduced depreciation, maintenance and operating costs; the only positive drive possible where great speeds are used, due to its smooth action (the safe limit of spur gears and chain drives is far below the limit of speed permissible for herringbone gears); saving in power consumption; maximum output of machine because highest speed practicable can be obtained from the calenders and mills; use of higher speed motors without additional countershafts, due to the very high ratios possible in reducing with this type of gear, resulting in reduced initial cost of installation; smaller size teeth for same amount of power transmitted, because the maximum bending moment of any tooth under load is far less than that to which a spur pinion is subjected under equal conditions, owing to the fact that more teeth are in engagement in herringbone gears at the same time; and a better quality of the finished product in calendering.

It is absolutely essential that the connecting gears of the calender rolls be of the herringbone type, otherwise marks would appear on the finished product, due to backlash and vibration. These gears have until recent years been cast tooth herringbone gears, which were a development of the

cast staggered tooth spur gear. The accurately generated herringbone gear is now displacing the cast tooth gear. Through the courtesy of the Falk Co. of Milwaukee, Wis., the writer is enabled to show some of the principal applications of the herringbone gear drives in the rubber industry. Many of the large rubber manufacturers of both Europe and America are now adopting this form of drive exclusively and equipping the calenders and mills throughout, from motors to the rolls, with herringbone gears. There seems little doubt but that herringbone gears, properly designed and cut, form the smoothest and most efficient drive known, and through their use and development we may hope for really silent machine drives. The field for the machined herringbone gear is great, its application being only in its infancy.

Figs. 1 and 2 show a complete herringbone equipment on a 26 by 72 inch three-roll calender. These calenders are usually driven by individual motors and the motor gear and pinion, together with the second motion pinion which meshes with the bull gear, are not shown. The effect of these gears on calenders is to entirely eliminate vibration and to enable the calenders to be run at much higher speeds and outputs than was formerly the case. With these gears it is impossible to produce flats on the calender rolls, a thing which quite frequently occurs on some classes of work where one roll has to be made of vulcanized rubber instead of cast iron.

The gears used for connecting the rolls of both calenders and mills are of special design and are illustrated in detail in Fig. 3. The teeth are longer than is usually the case for this class of gears and are generated in such a way that they are actually wider at the base than at the pitch line. This allows the rolls to be separated to any required extent up to a maximum of about  $1\frac{1}{4}$  inch, while the gears work with absolute smoothness

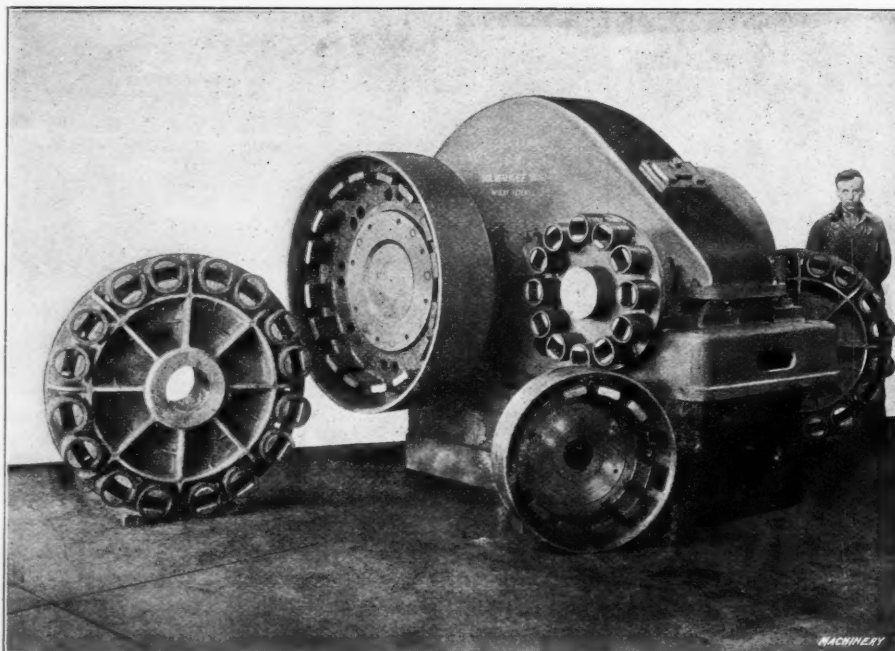


Fig. 5. Enclosed Herringbone Gears for Rubber Mill. Illustration shows also Flexible Couplings used in connection with Rubber Mills

and without interference in all positions of the rolls within these limits. The peculiar shape of the teeth illustrated is of great value for resisting the heavy bending stresses imposed by carrying the drive near the tips of the teeth when the roll centers are extended.

Fig. 4 shows a group of Wuest herringbone gears that were applied to driving a number of mills on one lineshaft. The pinions are not keyed to the lineshaft, but are bushed so as to float freely thereon. The drive is taken through jaw couplings, as shown, meshing with corresponding jaws cut in the ends of the pinion hubs. The driving half of each coupling is keyed to the shaft and the drive is transmitted through the jaws, but allows the pinions a free end movement which enables each pinion to align itself correctly with the gear which it drives. This arrangement prevents binding of the pinions on one side of the teeth, which might otherwise occur through longitudinal expansion of the lineshaft.

Fig. 5 shows a completely enclosed gear unit as used for driving the main shafts of rubber mills from high-speed electric motors. The illustration also shows the Falk leather-link flexible couplings which are used for connecting these units to the motors and lineshafts. These couplings absorb all shock and give a certain degree of elasticity to the transmission which is desirable for this class of work. They also take care of slight defects in alignments of bearings.

## ELECTRICAL SOLDERING

## PRINCIPLES APPLIED IN OPTICAL FRAME MANUFACTURE

BY WARREN E. THOMPSON\*

THE application of electricity in welding is understood by most metal workers, as it plays an important part in the manufacture of automobiles, wagon-tires, chain and other articles made of one or more different kinds of metal. There are two methods of welding in which the electric current is employed, *i. e.*, the arc and resistance methods. The arc is used to a limited extent for welding large broken parts and its application is considered more economical than

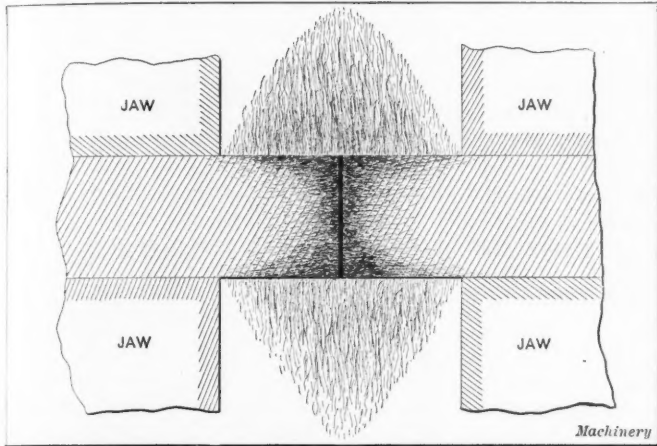


Fig. 1. Diagram showing Relative Volume of the Work that is heated by the Current

any other process, but the danger of handling current at the high voltages that are necessary makes its scope limited. The other welding process, as invented and developed by Dr. Elihu Thomson, consists of causing a heavy current of electricity at a low voltage to flow through the abutting ends of the pieces of metal to be welded. This heats the metal at the joint to a welding temperature, the joint being the point of greatest electrical resistance, and by forcing the ends of the work together until the molecules of the metal, or metals, flow together, the pieces become as one. This method of welding is generally carried out without the use of any flux, the pieces having been previously cleaned of all scale, grease, or other foreign substance detrimental to the process.

The underlying principle of this method of welding is based on the fact that any conductor of electricity offering resistance to the passage of the current will be heated if sufficient current is applied. This process is used extensively and the general advantages of cleanliness, simplicity, accuracy, economy, uniformity of product, safety to the operator, and general utility, tend to make it very popular wherever it can be applied. Exhaustive tests have proved that the electrically welded joint is from 75 to 95 per cent as strong as the original metal, and in cases where the upset or fin is not removed, the strength of the weld can be increased to above 100 per cent. It is also known that the electrical welding process is no more harmful to the homogeneity of the metal than any other heating process; probably less so, as the danger of overheating is eliminated.

What is true of welding is also true of the electrical soldering process about to be described, as in both processes the heat is developed by the same action, *i. e.*, the passage of a large current of electricity through the joint. This soldering process is a mechanical one and in operation the apparatus used is not likely to give any more trouble than any simple machine will. The wear on the clamping jaws makes it necessary to replace them periodically, but as they are comparatively inexpensive and constitute the only replacement necessary, the operating expense is very low. The amount of the current used in optical framework averages 1 K.W. hour per 1500 joints. This current can be purchased from the local lighting company or a generator can be installed which would probably reduce the current expense.

## How the Process is Conducted

The general method of soldering consists of holding the pieces to be joined by clamping jaws with the ends of the work in firm contact. A heavy current of electricity, regulated to heat the joint sufficiently to melt the solder, is next passed through the work. The solder, in the form of tape or wire, is then applied to the joint. It flows in and around all parts heated to the proper temperature, as when using a gas flame, but an important difference is noted: the "life" or temper is retained in pieces that have been electrically soldered, instead of their being left in an annealed condition as when heated with a flame. One theoretical reason for this is based on the fact that alternating current electricity travels on the surface of a conductor, and so the core of the work does not heat to a temperature sufficient to become annealed. This condition is illustrated in Fig. 1. The heat varies from a maximum at the joint to the normal temperature of the machine at the jaws, and the heated section would take some such form as shown. As the length of the work that is heated is relatively short, the distance between the clamps usually being twice the diameter of the work, the heat has not had time to run into the work before the joint is made and the current shut off. This is shown by the fact that two highly tempered wires soldered together by the electrical process offer the same resistance to being bent at any other point as at the joint. The yield point or bending strength of the metal is practically as high as before heating.

## Range of Electrical Soldering

Practically all the metals such as brass, copper, steel, German silver, gold, and silver can be soldered successfully in this way, and it is without doubt the most economical method for a continuous run of work. There are no noxious fumes or smoke produced in making an electrically soldered joint, and windows can be opened in warm weather without affecting the process in the least. The operator is thus able to do a full day's work each and every day, instead of experiencing

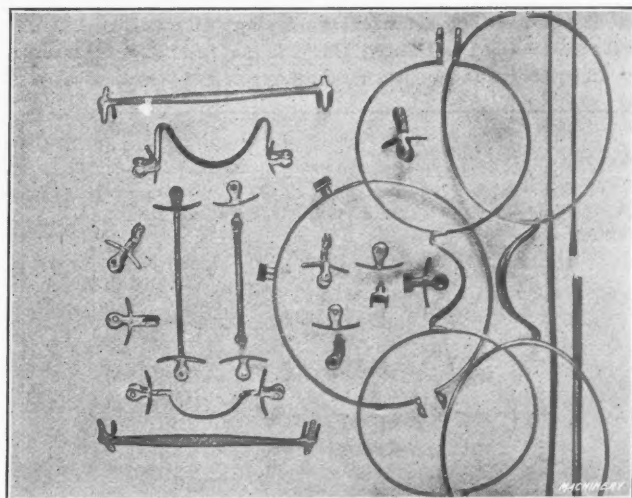


Fig. 2. Examples of Eyeglass Parts joined by Electrical Soldering

the fatigue that is caused by breathing the carbonic acid gas caused by the gas flames. The joint is made almost instantly, the time required to heat the joint, apply the solder, and shut off the current being approximately from three to five seconds, depending on the cross-sectional area of the joint. As the gripping jaws of the holders are made as large as possible, the heat is drawn from the work almost the instant that the current is shut off, allowing the work to be removed immediately.

## Examples of Electrically Soldered Optical Frames

A few samples of parts of eyeglass frames joined by this process are illustrated in Fig. 2. At the extreme right is shown a "cable-temple" before and after the joint is made. These

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cable ends are wound in a special machine and consist of two coils, right- and left-hand, one inside the other. The inner coil is made of brass wire wound on a steel wire arbor and then swaged to a specified diameter. The outer coil is made of German silver, gold filled, or any other stock that is desired, and it is pushed over the inner coil. After the assembled cable is soldered to the "temple," which is a solid wire with the center reduced, it is swaged to the final finished diameter. This leaves a very smooth and flexible ear-piece, and at the same time a stiff connection to the lens-holders. The soldering of the brass-German-silver cables caused some trouble through the brass fusing before the German silver would heat enough to flow the solder, but this was stopped by using a larger wire in making the secondary coil of the transformer.

Two specimens of "nose-pieces" soldered to "eyes" are shown to the left of the cable-templates. These eyes are formed by rolling a round wire to form a groove in it; they are then wound on an arbor and sawed apart. The end-pieces are sawed, assembled and peened in one machine, and they were formerly soldered by gas. Previous to soldering the "bridges" on by electricity, a long space was annealed on the eyes. This made a joint that could be easily bent, and various methods of striking in dies were resorted to in order to get back some of the temper. In all cases of soldering by electricity, the eye wire is left with nearly all of the original temper. Another eye with studs attached is shown encircling samples of "straps," "studs" and "end pieces" before and after assembling and soldering, and to the left of this eye are shown different forms of bridges and nose-pieces with straps, before and after soldering. Such parts, that have about the same cross-sectional area at the joint, are very easily handled. Electrical soldering is very valuable for straps, as considerable strain is brought on them by the lenses when worn or handled. This tends to bend them out of shape and the value of a strap with a high temper cannot be overestimated. Straps that are soldered by this process and struck inside have nearly the spring of tempered steel. Another noticeable feature is that the solder flows freely at a lower temperature than when heated by gas, as practically no oxidation takes place at the joint.

#### The Utilization of High Voltage Alternating Current

In the process of electrical soldering, alternating current is invariably used, although there is no fundamental reason why direct current can not be employed. For mechanical and

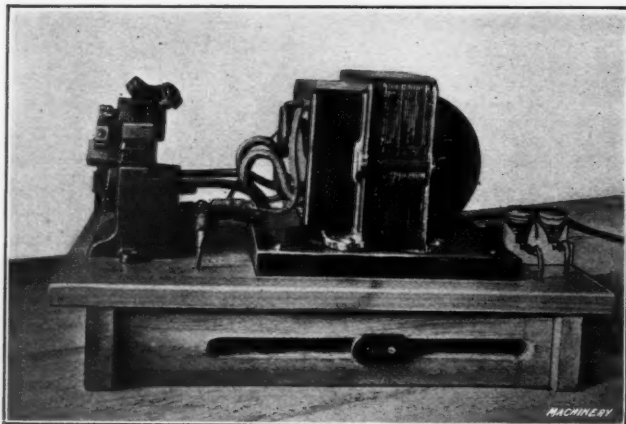


Fig. 3. Example of Unit Equipment for soldering Optical Frames

economical reasons, however, direct current is not to be considered. To make this clear, suppose a joint having a cross-sectional area of 0.125 square inch requires a current of 130 amperes at a pressure of 3 volts to heat it properly, and that an ordinary plating dynamo rated at these figures is used to furnish the current. It will be noticed that the work heats practically solid from jaw to jaw. Then suppose a joint having a cross-sectional area of one-half the first one, or 0.063 square inch, is to be heated by the same dynamo. A suitable resistance must be interposed in order to reduce the current to a point where the joint will heat properly without melting. This resistance will use current as though it were doing useful work and the small joint will cost

practically the same as the large one, as regards the amount of power consumed. On the other hand, it is claimed that the heating action of alternating current is more uniform, as it flows more on the surface; the heat is thus more intense on the surface and is evenly conducted to the core of the pieces, offsetting the effect of radiation and conductance.

The current used for electrical soldering should be a single phase alternating current of any frequency between 40 and 60. A higher frequency could be used, but it is not good practice for various reasons. A step-down transformer of the shell-core type is preferably used to reduce

the 110 or 220 volt feed pressure down to the  $1\frac{1}{2}$  to 5 volts required at the machine jaws.

It has been found that a pressure of from  $1\frac{1}{2}$  to 5 volts is sufficient for all optical frame work, and from 75 to 500 amperes of current is consumed. The use of a large transformer for small work is wasteful, as, although the current can be regulated as desired without much loss of energy, the work heats much more slowly than when a transformer of the proper capacity is used.

The machine transformer is usually connected in series with a single phase generator, but it may also be connected to one phase of a polyphase circuit or to either phase of a two phase generator.

The transformer is made by winding a coil of very large insulated copper wire around a core built up of iron sheets cut to shape by dies, each sheet being insulated from the others by shellac or some other medium. This coil, known as the secondary coil, is carefully insulated from the primary coil, which consists of a large number of turns of smaller wire wound around the secondary coil and its core. The number of turns of fine wire depends upon the number of turns of heavy wire and the current to be taken in and given out; also on the rules governing transformer design. The type of transformer illustrated in Fig. 3 is particularly well adapted for use in electrical soldering, as it can be used without changes with other work holders; and this would not be the case if it were built into the machine. As shown, it has the coils protected by an iron cover which not only acts as a case, but also as part of the magnetic field. Transformers of this type are very efficient—from 95 to 97 per cent of the current taken in being given out—and they are particularly suited for constant work.

#### Unit System of Electrical Soldering

The writer has developed a "unit system" of soldering and applied it very successfully in the manufacture of optical frames. This system consists in mounting all the working parts of the machine for each particular operation on a base-board or stand. Figs. 3 and 4 illustrate this idea; the transformer is mounted at the center, with a fuse box at the rear and the work holder at the front of the board. Under the base-board is located the adjustable rheostat operated by a sliding plate shown at the side. To set this machine up at any position in the shop, it is only necessary to run two wires from the feed circuit and attach a foot treadle to operate the clamp jaws and switch. This system allows the same transformer and other parts to be used with another machine in case of a change or the discarding of the original machine.

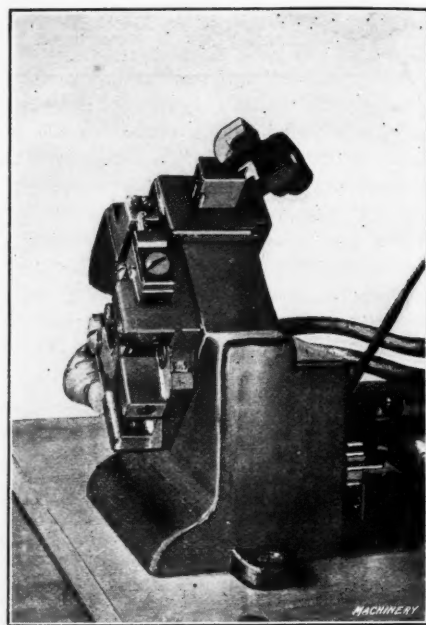


Fig. 4. Closer View of Work-holding Jaws shown in Fig. 3

There are two practical methods of controlling the heat obtained at the joint; one is by introducing an adjustable rheostat into the primary circuit, as illustrated; and the other method is to introduce a reactive or "choke" coil into the same circuit. Of the two, the reactive coil is undoubtedly the better, as there is practically no loss of power and an infinite number of adjustments may be made, whereas the rheostat is limited to the number of contact points used. The difference in loss of current is an inappreciable amount more with the rheostat, but it can be made for little expense and for that reason has been used more than the choke coil. The writer uses the rheostat control on nearly all of his equipments on account of its simplicity, the ease with which it may be built and the simplicity of operation.

A machine for soldering straps to eye-pieces and bridges is shown in Fig. 5. This machine or holder consists of a base *A* with a vertical slide *B* working in a slot at the rear. A second slide *C* also works in another slot at the rear, the slot being inclined at 45 degrees to the base. This slide *C* is operated through a lever *D* which receives its movement from the slide *B*; the lever *D* is pivoted in the base. The slide *B* is provided with a spring tension which allows the lever *D* to keep a constant pressure on the slide *C* while the slide *B* continues to move. The lever *D* works in a slot cut through the slide *C*, this slide carrying a cam-operated swinging arm at its upper end to which the clamping jaws *G* are attached. This upper jaw is designed to swing away from the work and leave it clear to facilitate handling.

At the rear of the machine and attached to the base there is a switch which is operated by a pin in the slide *B*. At the front of the base and insulated from it is the casting *I* which is milled to receive an arm *L* that is free to move on a pivot, but the motion of the arm is limited by the adjusting screws *J* and *K*. The arm is held against the screw *J* by means of an adjustable spring tension *N*. There is a jaw *O* at the upper end of the arm, which, in this case, holds the strap in the proper relation to the other part to which it is to be soldered. The contact of the jaw *O* with this strap is made by the pressure of the spring *N* against the arm *L*, and the strap is held against the part to which it is to be soldered, which is carried between the jaws *P* and *G*. The jaws are made interchangeable for different classes of work and may be easily replaced.

At the lower end of the casting *I*, one end of the secondary or low pressure circuit is connected by means of the terminal *T*, and a spring brush *R* is used to insure a low resistance contact between the casting *I* and the rocker arm *L*. The lower clamping jaw *P* is attached to the base *A* and the jaw is provided with a gage for aligning the part held in it. The slide *B* is held at the top of its movement by means of the spring *S*. Two points of the switch control the primary or high pressure circuit, and the other two points operate on the secondary which is in the circuit with the jaws of the machine. A chain connects the lower part of the slide *B* with a foot treadle which is placed under the bench in a convenient position for the operator.

The operation of this holder is as follows: Two pieces

to be joined, previously covered with a non-scaling or protective mixture, have the joint end of one piece dipped into the flux. They are then assembled in the proper relation to each other in the jaws of the holder, which are so arranged that the rocking arm is away from its stop when the work is in place. The foot treadle next is depressed until the upper clamp jaw grips the work; in this case only one part is held rigid. The other piece—which is a strap—is guided by its form and a teat on the piece held in the rigid jaws. The solder, in the form of wire, is then placed on the junction and the foot lever depressed further until the current is connected. Almost instantly the solder flows and runs around the joint, when the foot treadle is released entirely, and the work, which is left free, is taken out with a pair of tweezers. On work which is very small and difficult to handle with the fingers, tweezers are used; but such work as soldering temples together, bridges to eyes, bridges to straps, or eyes to studs, is handled with the fingers. The heat is held at the joint instead of spreading as it does when heated with the flame, so it causes the operator no discomfort to take the joined pieces out as soon as the jaws are opened. The jaws are brushed clean at intervals, using a short hair stiff bristle brush for this purpose.

The idea of using a spring tension jaw was developed by

the writer after having had considerable trouble caused by particles of dirt or burrs getting into the junction, also by not having the two ends fit together properly to form a contact of low resistance. When both pieces were held rigid, these particles or points would fuse and in most cases necessitated refinishing the points before a joint could be made. In some cases it was possible to release the parts, push

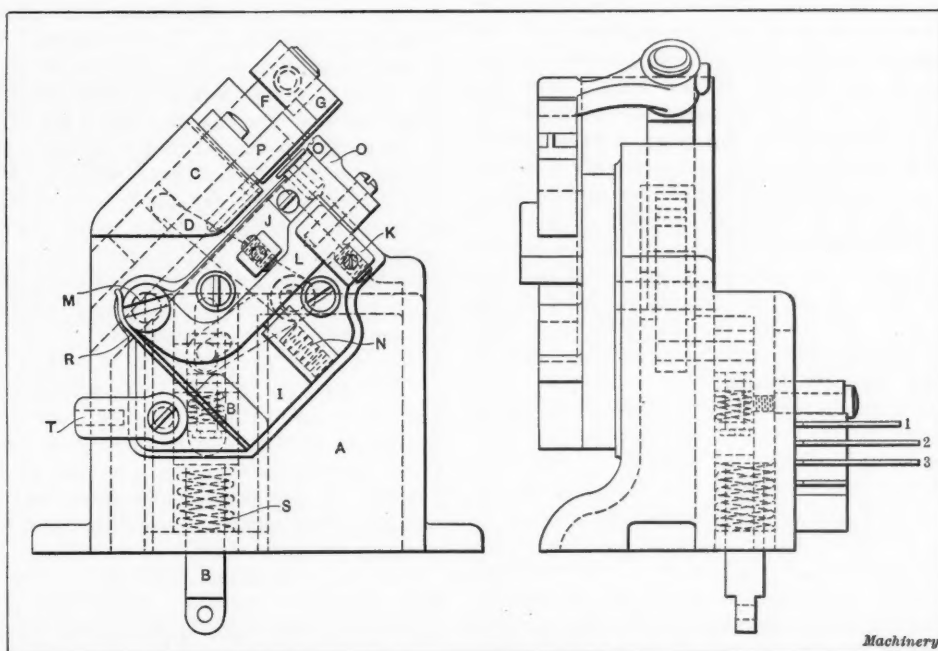


Fig. 5. Machine for soldering Straps to Eye-pieces and Bridges

them together with the fingers, and get the solder to take, but the method of clamping both parts rigidly always caused trouble and kept the actual production factor at a low point. By the use of the movable jaw, all of this trouble was eliminated as the constant spring pressure holds the ends in firm contact, automatically keeps the ends together in the case of burrs or other points fusing, and prevents any break in the contact while the current is being applied. In the welding process, the ends are forced together while at a welding temperature, but this changes the form of the ends and shortens the pieces; consequently it could not be applied to optical work, as there must be no change in the size or form of the pieces to be joined. The spring behind the rocking arm *L* in Fig. 5 is adjusted to provide just sufficient tension to keep a constant pressure on the junction without deforming or upsetting the ends, thus forming the joint when the ends become hot. The jaws of the holder are made as large and heavy as possible to allow of their working continuously without heating. These jaws are made of copper, which has been found best for this purpose on account of the low resistance of the contact made between them and the metal to be operated on. Copper is one of the best conductors of heat and electricity that is possible to use commercially, and for this reason will not only heat less by the passage of the current, but

will draw the heat away from the work quicker than any other metal.

#### Preparing the Work to Prevent Scaling

To prevent gold-filled metal from scaling or "burning" at the joint, it is customary to cover the work with some preparation to prevent oxidation. Probably the best, and at the same time the simplest, method of preparing the work is to place it in an ordinary flour sieve, cover it with commercial boracic acid, and then shake all loose powder out. This leaves the parts covered with a thin coating of dust which becomes liquid at a low red heat and prevents the air from coming into contact with the surface of the gold. Another method is to make a solution of the boracic

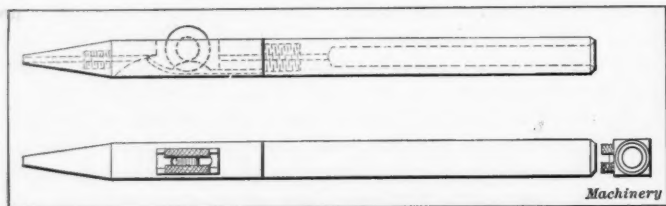


Fig. 6. Holder for applying the Solder by Hand

acid and water, dip the pieces into this solution, drain off the surplus and allow them to dry. In no case, however, should any solution be used that will leave a hard film over the parts, as this would prevent a clean contact with the clamping jaw, create a resistance that would cause an arc to develop, and spoil the surface of the work. The flux generally used is borax and it is prepared in the following manner: A piece of genuine slate, the green colored variety which is the hardest being the best, is thoroughly cleaned; a few drops of water are placed in the center and a thick, creamy mixture of borax is made by rubbing a piece of crystalline borax in the water on the slate until the desired consistency is obtained. The proper mixture is best determined by actual trial; a mixture that is too thin or too thick will either cause the solder to remain in one spot, instead of flowing through the joint, or create an unclear contact and interfere with the heating.

The solder in the form of wire may be held in the hand in a holder, as shown in Fig. 6, or some such arrangement as the one shown in Fig. 7 may be employed. This consists of a chuck at the top of a wire, bent about as shown, and having a metal ball at the lower end heavy enough to balance the wire and chuck in an upright position. This wire is held by a screw in one member of a universal joint which allows the chuck to be moved freely to any position in front of the clamping jaws and take a convenient position to allow the solder to be grasped by the operator. When a holder of this type is used, both hands are free to place and adjust the work and apply the solder quickly.

Considerable trouble, owing to the overheating of the joint, has been experienced and overcome by the rocking arm of

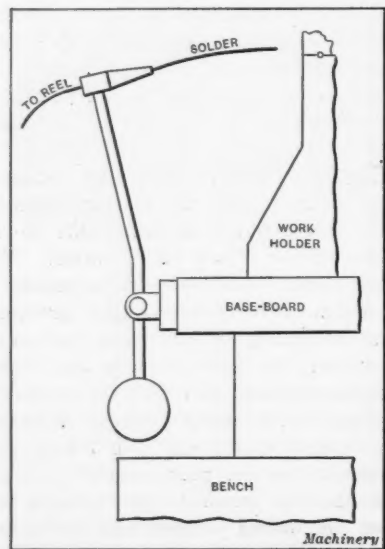


Fig. 7. Bracket for supporting Solder Holder on the Machine

the work holder. This heating caused the metal to become porous or "rotten" and the parts would break at either side of the joint upon the application of the slightest pressure. Some trouble was also overcome at the switch by making the contact points of pure silver. These points would fuse and weld together when copper was used, but the silver points stopped this trouble at once. Electrical soldering is a comparatively new process and has not been applied extensively as yet. It is

the opinion of the writer, however, that this process is to become more popular and will be taken up by all large concerns that have a large number of interchangeable parts to braze or join.

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### SAM AND HIS TROUBLES

BY A. P. PRESS

I have been forty years in the shop, twenty-five of which was passed as foreman and superintendent. Now my two boys are growing up and going "through the mill" themselves, and the troubles they run up against in their everyday work are usually brought home in some form or other and put up to "dad." In thrashing out what is new to them but old to me, it struck me that perhaps I might help out some other man's kid who is trying to fight his way through the ranks to the top, but hasn't any "dad" to fall back on. Although, to tell the truth, a boy who builds his own foundations has a better rest under his feet than one whose dad stands back of him. However, I will give you a few of their troubles and remedies, and the boy who seems to need the coat can put it on if it fits.

One of the boys is foreman in a large pattern shop, and the questions that come up are very similar to those that came up to me twenty or more years ago, except they seem to be a little more acute, and you have to be a little broader minded and use a little more diplomacy and "horse sense" in handling them now. One is the labor question. This I well know is a delicate subject, and should only be spoken of in whispers, but in spite of this fact it is eternally coming up. Sam came home one day, his face as long as his arm, and said:

"Dad, it's no use. I've got to have some advice whether you've got it to give or not. We have four big patterns half finished in the shop and the boys have all been working every night until 9 o'clock, and I've heard you say many a time you can't reason with a man whose worked thirteen hours a day. Now they've all hit me up for double pay for overtime, and the job won't stand it. What shall I do?"

"Are they all union men, son?"

"No, not yet, but soon."

"Well go back, and in the morning get the boys together, and put it up to them; tell them how the case is, just where you stand on the pattern work, what you're going to get for them, what they're costing you, and how much you'll lose if you have to pay them double time; and if they stand by you and see those patterns out, you stand by them; but if they won't, why 'buck' them."

Sam went back and took my advice. He had a heart-to-heart talk with the men. There were only ten of them, and out of the ten eight were willing to help him pull them through on the time-and-a-half basis, but the other two were not that kind. Well, you know. Anyhow, no need of my telling. It ended in the boys all walking out and leaving Sam with the errand boy, a helper, one good patternmaker who "wouldn't jack up his job for anyone," also, four half finished patterns on the floor. Sam was very solemn when he came home that night. He did not say a word, and I let him alone. Sometimes contemplation is good for the soul. But the next morning he got busy, and sent out some twenty letters to all the different patternmakers whom he knew to be good men and good workers, and, to cut a long story short, five of them came on and went to work and helped him out of the hole, and the next lot of patterns was taken at a price that would take care of the overtime work.

Before starting in on the new work, however, he had another talk with the men.

"Boys, it's like this: You are demanding the utmost of me in the way of wages, now I am going to demand the utmost of you in the way of work. Seven o'clock is going to mean seven o'clock right at the bench, and overtime means that there isn't going to be fifteen minutes out for lunch and your pay going on. It's going to mean, not only double time, but that every hour means sixty minutes of work." And so far it has worked out very well.

The moral of it, as I told Sam the other night, is this: Treat the men like men, and draw them if you can, but if they won't be drawn and want to be driven, well then drive.

## EXTERNAL HOLDING DEVICES FOR SECOND-OPERATION WORK\*

CHUCKS, FIXTURES AND LOCATING DEVICES USED IN LATHES AND BORING MILLS

BY ALBERT A. DOWD†

IN the majority of cases, work which is to be handled in more than one setting is so treated in the first of these that an interior surface can be used from which to locate the piece in the second setting. For work of this nature some kind of internal holding device, such as an expanding arbor or locating plug with clamps, is conceded to be of the greatest utility. (See "Arbors for Second Operation Work," October, 1913.) Frequently there are instances, however, which require an entirely different method of holding, namely, by some form of contracting device such as a set of collet jaws, a step chuck, soft jaws or some other scheme of a kindred nature. Obviously, one of these devices would only be found necessary when an outside finished surface was to be used as a locating point.

There are a number of conditions which affect the design of arrangements of this sort and a number of vital points in

\* For articles on this and kindred subjects see MACHINERY, November, 1913, "Holding Devices for First-operation Work"; October, 1913, "Arbors for Second-operation Work," and "Work Holding Arbors and Methods for Turning Operations"; August, 1913, "Knock-off Arbors for Threaded Work." † Address: 84 Washington Terrace, Bridgeport, Conn.

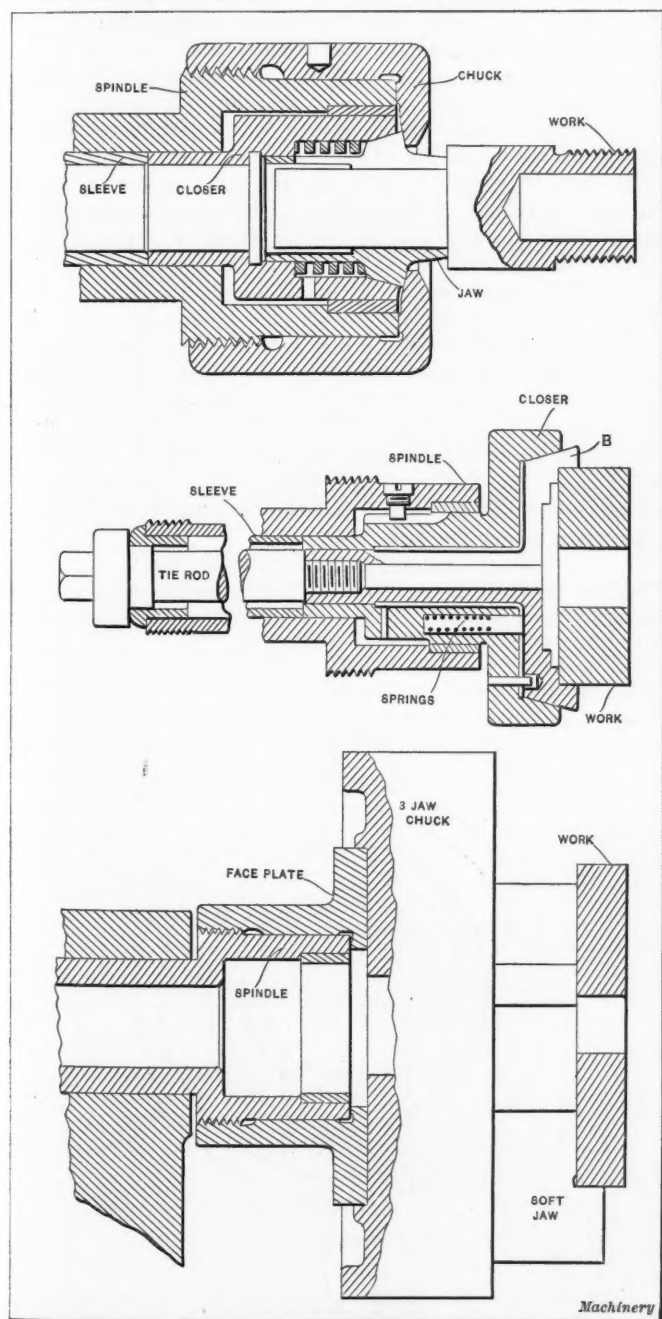


Fig. 1. Collet Chucks and Soft Jaw Chuck for External Holding of Small Work

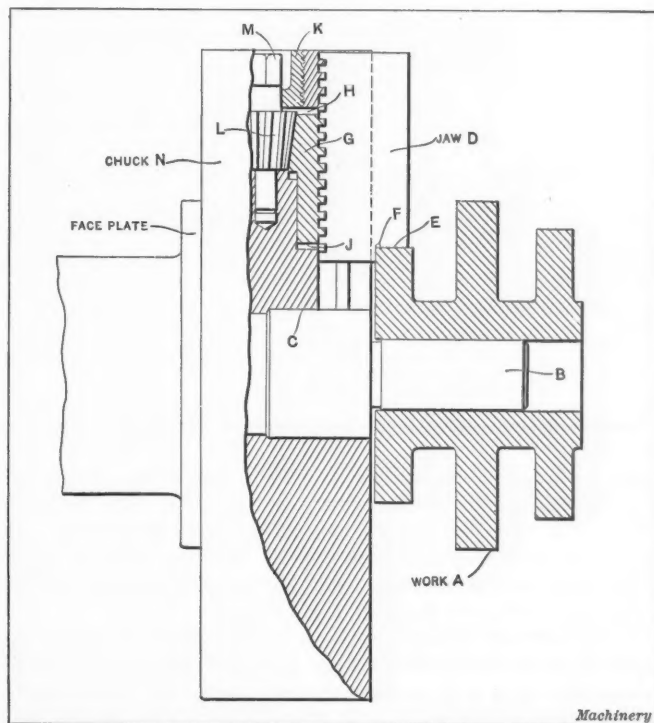


Fig. 2. Holding Device employing a Three-jaw Chuck with a Floating Scroll

construction which should not be overlooked. In the first place, the form of the work itself and the material from which it is made, together with the thickness of the walls used as locating surfaces, are prominent factors which have a strong influence on the method of holding. The size and weight of the casting naturally determine to a certain extent the type of machine most suited to the work. The degree of accuracy required in the finished piece is also a factor in determining the type of holding device to be used. The types of machines most frequently employed on work requiring fixtures of this kind are the horizontal screw machine or turret lathe, the vertical turret lathe, and the vertical boring mill. A few of the most important points in the design and construction of this class of fixtures are given in the following paragraphs.

## Points in Design

1.—Decide on a method of holding which will not produce distortion in the finished work. Consider the thickness of the metal at the holding points, and note whether there is danger of crushing if considerable pressure is applied. Use a driver of some kind whenever possible, as this will be of great assistance in taking the thrust of the cut, and will therefore do away with the necessity for excessive pressure in holding. It may be permissible in some cases to drill a hole in the work for the express purpose of furnishing a place in which a driver can be inserted.

2.—Decide on the type of machine to be used, selecting that most suited to the work, taking into consideration the diameter and weight, and the speed at which it should be run to secure maximum production. In this connection it is well to bear in mind that the diameter to be cut determines the speed, irrespective of the outside diameter of the work itself. For example, a comparatively small hole in a hub might be machined when the outside diameter requires no machining whatever at this setting. In a case of this sort it would be advisable to select a machine capable of sufficient speed to produce maximum cutting speeds at the point where the cut is to be taken.

3.—Rapidity of operation is important; this requires accessibility of various clamps, screws, or other adjustable por-

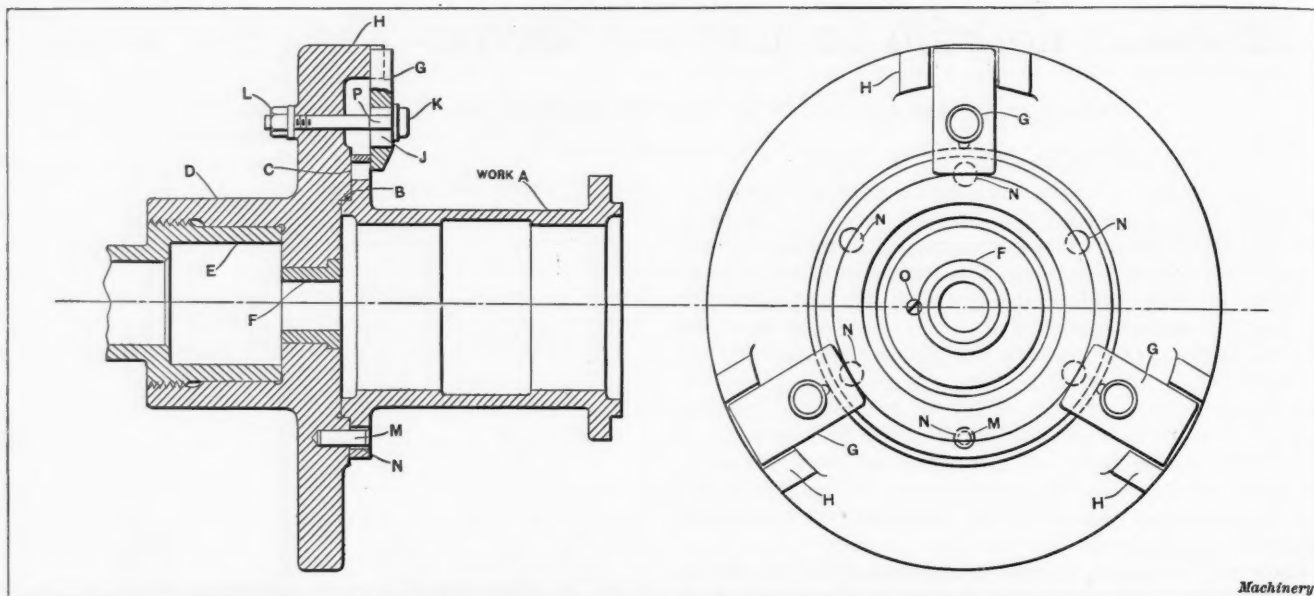


Fig. 3. A Fixture for Second Operation on a Motor Frame

tions necessary to the proper holding of the work. If a number of nuts are to be tightened, see that they are made of such a size that one wrench can be used for all of them. It is a very good idea to make nuts of the same size as some of the nuts on the machine itself, so that the regular wrench which goes with the machine can be used.

4.—Provide for positive location for the work, so that variations will not occur in shoulder distances when the piece is completed. It is well to make the locating points conveniently accessible so that they can be easily kept free from dirt and chips. Separate points, pads or studs should be used for locating, whenever possible, rather than unbroken surfaces.

5.—The accuracy required in the finished work should be carefully considered. When very close work is called for it is well to make suitable provision for wear in the moving parts and also to allow for grinding or lapping when making the fixture.

6.—Rigidity of design is important. It is well to remember that the closer the work can be held to the end of the spindle the less the overhang will be. Less overhang means less liability to chatter and also greater rigidity. Extra strength should be provided at points where there is excessive strain, and ribbing may be put in where needed. The balancing of the fixture should also be looked into, especially if it is to run at high speed.

7.—Safety of the operator should be considered and care

taken in the design to provide guards over projecting lugs, set-screws, etc. Various methods will suggest themselves to the designer during the progress of the drawing, and a little thought on this point will be greatly appreciated by the operator. Projecting set-screws, exposed gears, etc., are growing more and more out of favor in machinery, and it is time that such things were done away with on fixtures also.

8.—The cost of the fixture should bear a certain relation to the number of pieces for which it is to be used; by this is not meant that it should be in a certain exact proportion to it, but that it should be taken into consideration while designing, so that the cost will not be too great as compared with the number of pieces to be machined. For example, if a fixture is to be used for only a hundred pieces, it should be designed as cheaply as possible, so that when the fixture cost is distributed among these pieces it will not increase the cost of production any more than can be helped. On the other hand, let us suppose the fixture is to be used for a lot of 10,000 pieces. It is then evident that an elaborate fixture having all possible provisions for rapid clamping, etc., would be in place, for the cost distributed among this number of pieces would be very small and the time saved would more than make up for the extra cost.

#### Outside Holding Devices for Small Work

There are several methods by which small work can be successfully machined when a second setting is necessary in

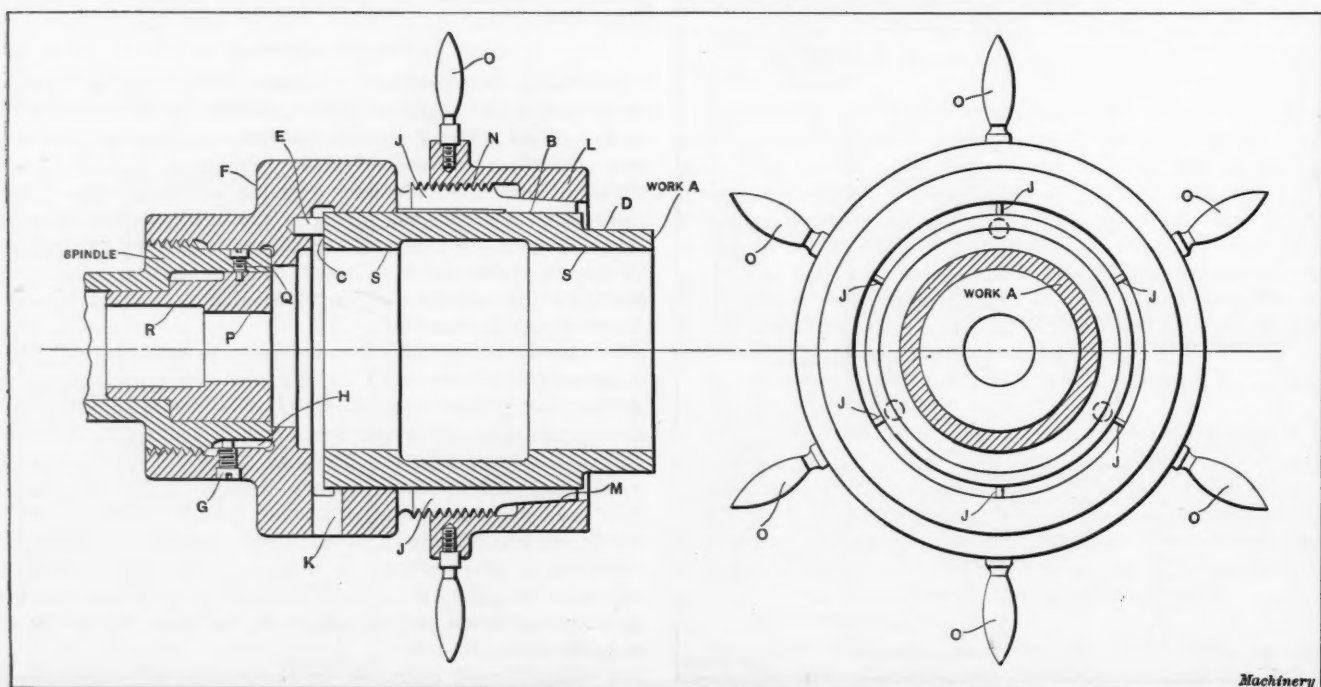


Fig. 4. Split Chuck used for a Bearing Sleeve

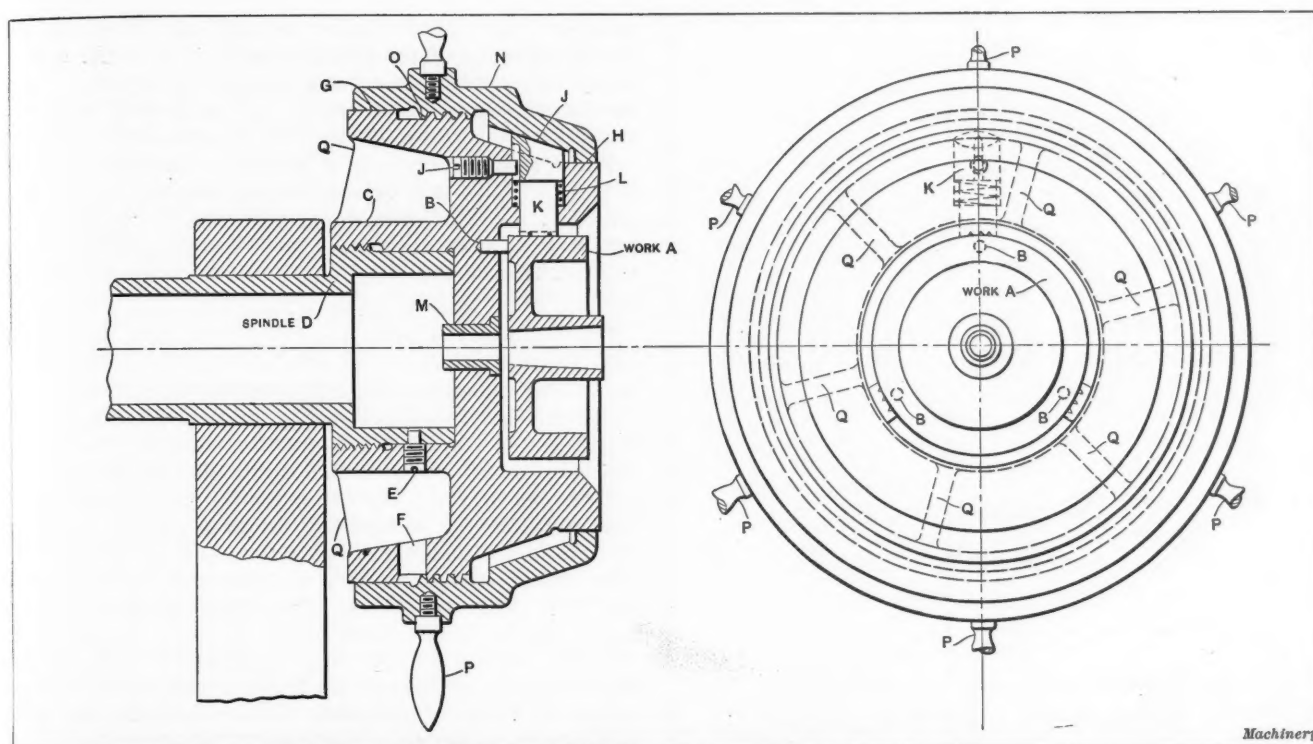


Fig. 5. Special Type of Chuck with Clamping Pins for a Small Flywheel Casting

which the work is held by the outside previously finished surface. The device most used is probably some form of collet jaws, such as is shown in the upper portion of Fig. 1. For second-operation work on bar stock, a method of this kind gives very satisfactory results and is too well known to require a detailed explanation. The collet jaws are closed in on the work either by drawing them back into a tapered body or by forcing a tapered body over them, thereby causing them to contract; the operating lever or wheel is at the rear end of the spindle. In the case shown in the illustration, the second of these methods is used. The machines supplied with this type of collet mechanism are the horizontal turret lathes made by the Pratt & Whitney Co., Hartford, Conn. A noteworthy feature of this collet chuck is the fact that the operation of the closing mechanism does not tend to move the stock lengthwise. It is therefore especially valuable for second-operation work.

Another method employing a step-chuck is shown in the second illustration of the same figure. This method is often used for second-operation work on gear blanks or pieces of a similar nature. The steel blanks *B* can be stepped out for several sizes, as indicated. The closing operation is performed by means of the collet mechanism, and it may be noted that, as in the case of the collet jaws, there is no longitudinal movement of the work. This method is less frequently used

than the collet jaws, but it is very useful for many kinds of comparatively small pieces. This device is also a product of the Pratt & Whitney Co.

One other very widely used arrangement is shown in the third illustration, Fig. 1. This is a set of soft steel or cast-iron jaws which are bored out to the proper size, and then clamped onto the work by means of the regular chuck mechanism. Jaws of this kind are used for a great variety of work, both small and large. They are adapted for use in two-jaw, three-jaw, and four-jaw chucks, and are made up in a great many forms to suit peculiar conditions. In the two-jaw variety they are frequently formed to fit some odd-shaped piece. In the three-jaw type they are usually simply bored out and shouldered; the four-jaw style is not as common as the other two. In the operation of a four-jaw independent chuck with soft jaws, two of these are left set while the other two are used for clamping. One of these methods is in use in every shop or factory in the country.

#### Holding Device using a Three-jaw Chuck with a Floating Scroll

The work shown at *A* in Fig. 2 is an alloy steel jack-shaft gear for an automobile, part of which has been machined both inside and outside in a previous setting. As the size of the hole was too small to permit the use of an expanding arbor, the arrangement shown was decided upon. A regular three-jaw geared scroll chuck *N* of a standard make was selected

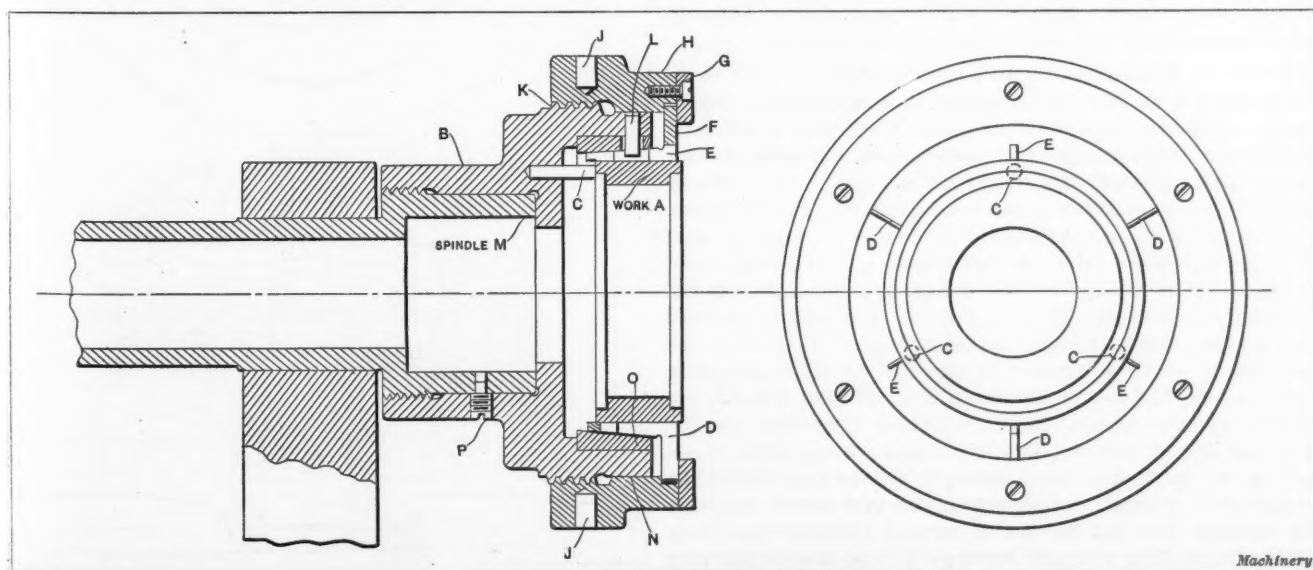


Fig. 6. Collet Chuck for a Steel Forging

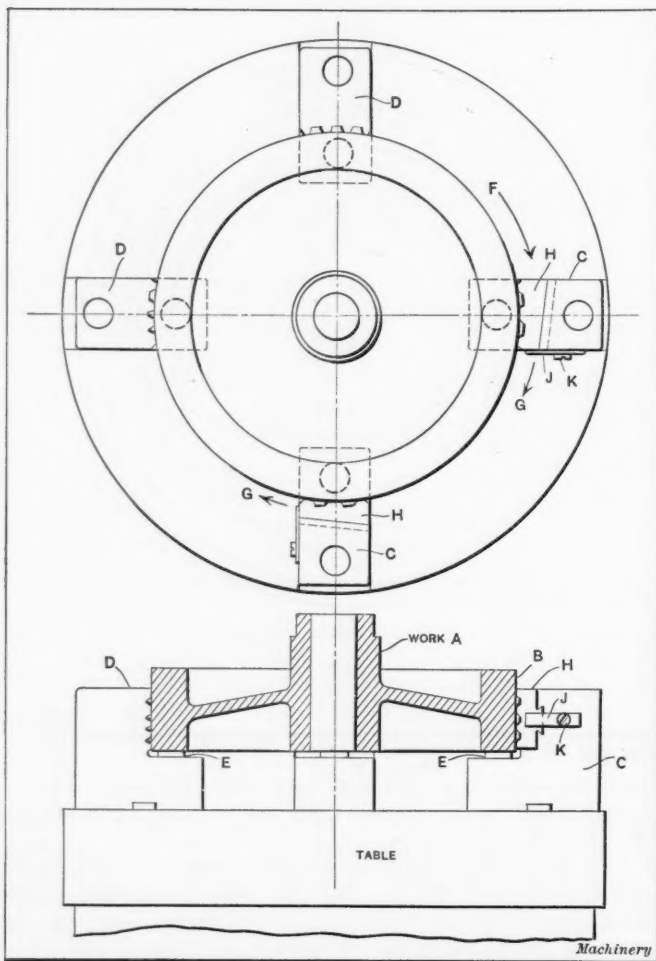


Fig. 7. Chuck for a Boring Mill having Special Secondary Jaws

for the work. The body of the chuck was bored out at *H* and *J* to a dimension  $1/16$  inch larger than the width of the scroll ring *G*, thereby permitting the scroll to float radially. The revolving motion of the scroll is accomplished in the usual manner by means of the pinion *L* which is squared at the end *M* to receive a socket wrench. The bushing *K* acts as a retainer. The radial movement of the jaws *D* is obviously accomplished by the revolution of the scroll ring which meshes with teeth cut on the under sides of the jaws in the regular way. The body of the chuck is bored out at *C* to fit the locating plug *B* which is ground to the size of the hole in the work. The jaws *D* are bored out at *E* to the diameter of the gear blank at this point, and they are recessed at *F* as a precaution against chips or dirt. It will be seen that while the locating is done by the plug, the jaws grip the work firmly and act as drivers without any tendency to throw any strain on the plug. The scroll, having a floating action, takes care of any inaccuracies. This arrangement is rather unusual, but its action was very satisfactory in this instance.

#### Locating Fixture for a Motor Frame

The work *A* in Fig. 3 is a casting of a motor frame which has been previously rough-bored and faced and shouldered on one end. This fixture was designed for finish-boring and facing the other end, and sizing the shoulder. This type of fixture is not uncommon for various kinds of work requiring a second setting. After the first setting, a drill jig is used to drill the flange holes *N*, so that a means for driving is provided. This is always an advantage, as less strain is imposed on the clamps. The body of the fixture *D* is screwed fast to the spindle *E*, and is recessed at *B* to receive the shoulder on the casting, which acts as the locating means. The body casting is also faced off at *C*, and the driving pin *M* inserted as a driver. This pin is made  $1/64$  inch smaller than the drilled hole to allow for slight inaccuracies in the drilling of the flange. The bushing *F* acts as a guide for the tools used. A screw *O* (shown in the end view), prevents the bushing from pulling out or turning around. The three clamps *G* are of the ordinary flat type, slotted at *J* so that they can be pulled back out of the way when placing the work in

position. The bolt *K* passes through the clamp and body and is drawn up by the hexagon nut *L* on the other side, the portion *P* of the screw being squared up where it passes through the clamp to prevent its turning around when tightening. The lugs *H* are slotted so that the ends of the clamps will not tend to twist out of position. This type of fixture is quite effective, but depends for its accuracy on the fit obtained at *B*. When used for a great number of pieces it is advisable to make a hardened and ground steel ring instead of depending on the cast iron for accuracy at this point.

#### Split Chuck for a Bearing Sleeve

Fig. 4 shows a bearing sleeve which has been turned at *B* and *D* and faced at *C* in a previous operation. The fixture shown was made for facing the other end and boring the two surfaces *S*, but it was not entirely satisfactory, due partly to a tendency to remain closed after the clamping ring was unscrewed. A lack of spring in the chuck body was the cause of this; as it was made of machine steel, a great deal of elasticity could not be expected. Another bad feature was the position of the thread *N* which was so situated that considerable trouble was experienced in keeping it free from chips and dirt. This example is given to illustrate some of the faulty points in its construction, so that "what-not-to-do" may be clearly seen. The body of the chuck *F* was made of machine steel and was pack-hardened to obtain as much spring temper as possible. This body was screwed onto the spindle and held in place by the test-screw *G*, which enters a slot *H* in the end of the spindle. Three pins *E* act as longitudinal stops for the work.

The inside of the chuck body is bored out to fit the work. It is threaded on the outside at *N* and tapered at *M*. Six saw cuts *J* are equally spaced around the periphery to allow for expansion and contraction. An operating collar *L* is threaded and tapered to fit the body, and six handles *O* screwed into place for operating purposes. These handles were afterward

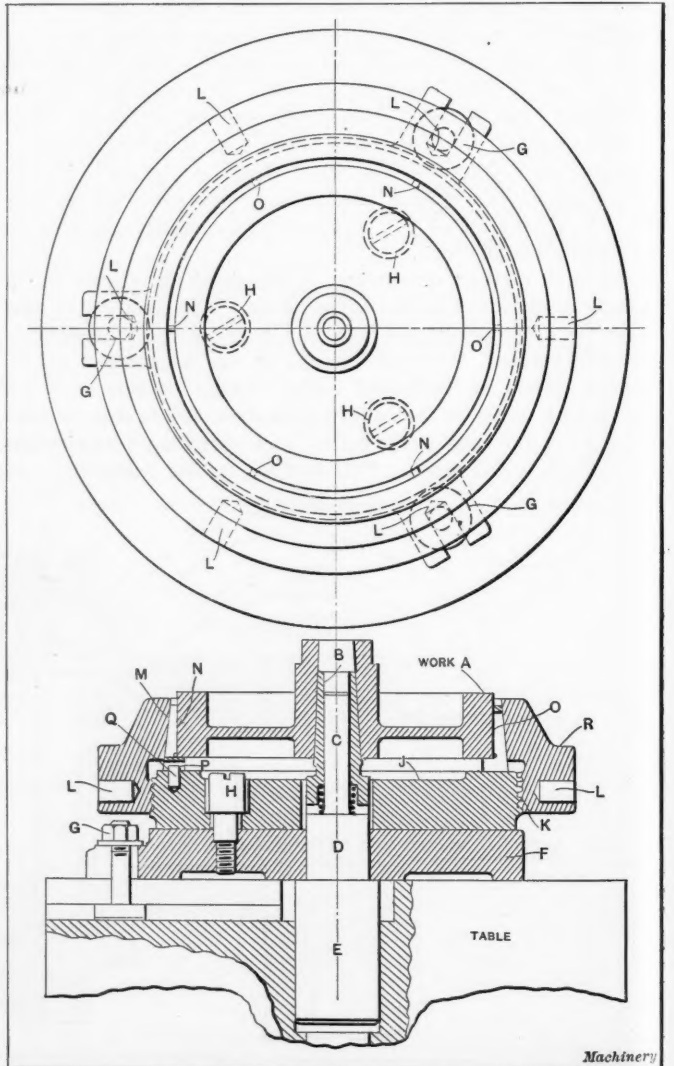


Fig. 8. Collet Chuck for Boring Mill having a Floating Action

removed by the operator (as a precaution against being injured by them) and a piece of drill rod used in the holes in place of the handles. A tool steel bushing was fitted to the spindle and held in place by screw *Q*. This bushing was relieved at *R* and ground to a running fit for the boring-bar pilots at *P*. Three holes *K* were drilled in the body so that accumulated chips and dirt could be readily brushed out. This entire chuck exhibits a lack of forethought in its design and forms an example of a poorly constructed device. As it was designed by the writer, he has no hesitation in condemning it rather forcibly, but would add that it was made a number of years ago. The recognition of its shortcomings has been of great assistance in subsequent designs.

#### Contracting Pin Chuck for a Small Flywheel Casting

A somewhat expensive device is shown in Fig. 5 for handling the small casting *A* on a horizontal turret lathe. It will be noted that the arrangement of the chuck is such that the weight is kept well back near the spindle bearing, so that excessive overhang is avoided. The body *C* is made of cast iron and is screwed onto the spindle *D*, where it is secured by the test-screw *E*, access to which is obtained through the hole *F*. Three pins *B* serve as longitudinal stops for the work, and these are so placed that they can be very easily kept free from dirt and chips. The three jaws *K* are cylindrical, and are forced outward by the coil springs *L*. The test-screws *J* enter slots in the jaws and prevent them from turning. The jaws are hardened, ground and lapped cylindrically, after which they are assembled in the chuck body and ground on the taper and also at their bearing points on the work. The operating collar *N* is a steel casting which is ground to a nice running fit at *H* and *G*, and threaded with a coarse pitch Acme thread (double) at *O*. It is ground to a taper at *J* corresponding to the taper on the ends of the jaws. It is well to note that the construction and accuracy of the chuck would have been materially improved by making a tool steel taper ring and inserting it at this point in order to minimize the wear and provide for means of adjustment. The handles *P* are a rather dangerous feature, but they permitted the operator to use both hands in tightening the jaws; this was

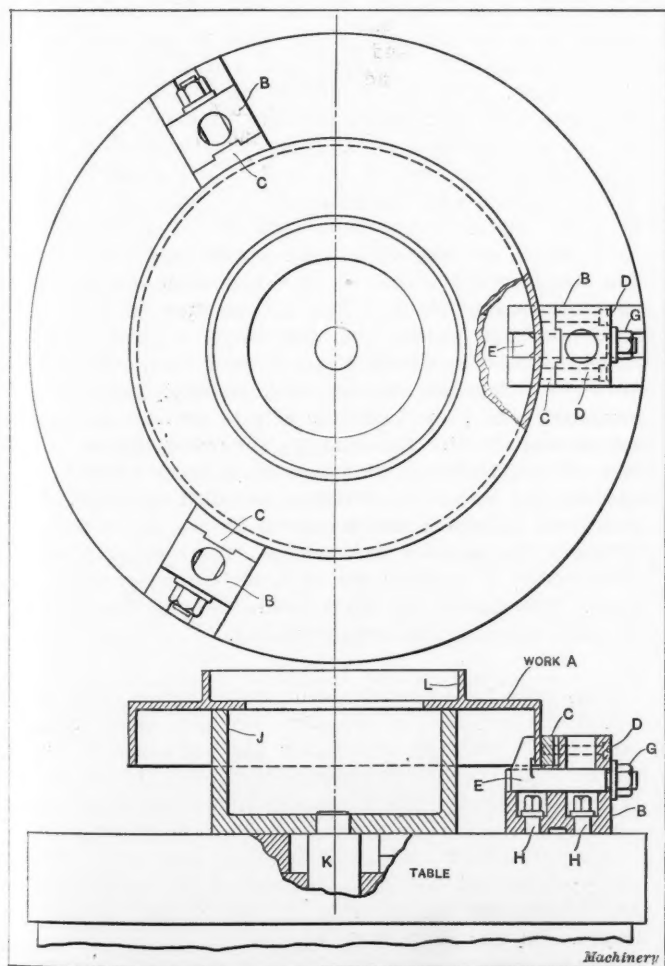


Fig. 9. Arrangement used for holding Thin Work on the Boring Mill

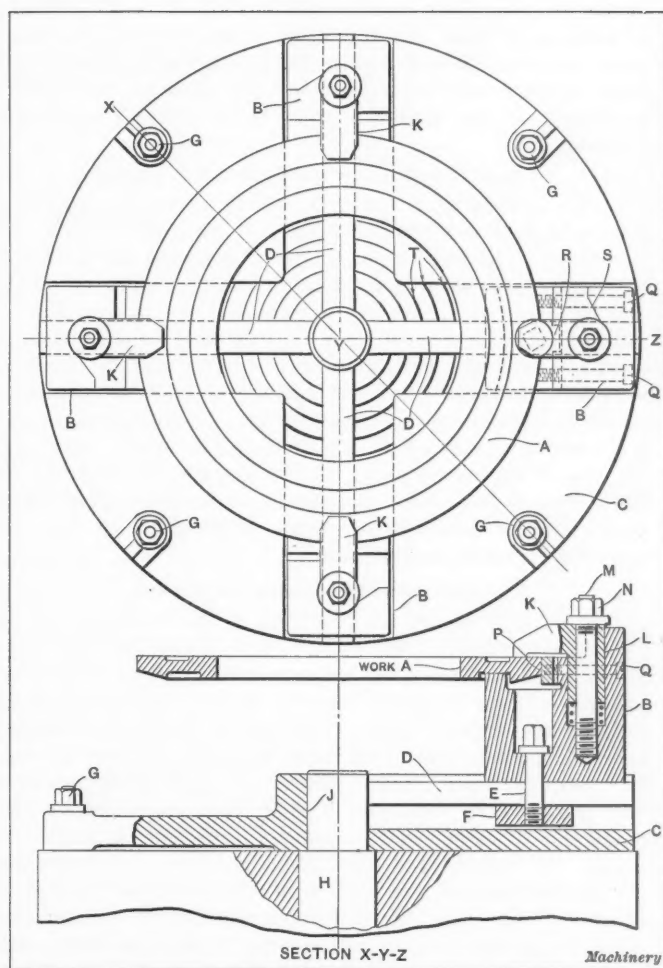


Fig. 10. Special Fixture for holding a Number of Different Sizes of Bevel Gear Blanks on the Boring Mill

of considerable advantage, as the power required took about all the strength he had. A more acute angle on the pins in their relation to the collar would have been of some assistance, but the thread diameter and frictional surfaces were large, so that ease of operation could not be readily attained. The bushing *M* acted as a guide for the tools used in generating the tapered hole. It should be noted that the threaded portion is made somewhat free and the fitting done at *H* and *G*. These closely fitting surfaces are also of assistance in keeping chips and dirt out of the mechanism.

#### Spring Collet Chuck for a Steel Forging

The work shown at *A* in Fig. 6 is a steel forged collar which has been previously turned and faced on one end. The body of the chuck *B* is screwed onto the spindle *M* and is prevented from turning by the test-screw *P*. A hardened and ground steel ring *O* is forced into the body of the chuck, and is tapered to coincide with the outside of the spring collar *F*, which is prevented from turning by the pins *L* that act as drivers in the elongated slots shown. Six slots are cut alternately at *D* and *E* to permit uniform contraction and expansion. It will be noted that the first-mentioned of these slots pass through the flange and part of the collar to a point close to the end, while the alternate slots are cut from the rear end toward the front but do not pass through the flange. In passing, attention is called to the fact that a slight tie is left at both ends of all the slots, this tie being cut out, at the end intended to be cut through, with a thin wheel after the grinding operation. If this were not done great difficulty would be experienced in grinding. The operating collar *H* is made of cast iron and is threaded at *K* with an Acme thread, 4 per inch. A recess is cut at the forward end to receive the flange of the spring collet. The cover plate *G*, made of steel, is screwed fast to the end of the operating collar. Six holes are provided around the periphery so that a piece of drill rod can be used to revolve the collar, thus forcing the collet in or out and causing it to contract or expand. The cylindrical bearing at *N* insures accuracy. Three stop-pins *C* are used to locate the work in the chuck longitudinally. One

of the disadvantages of this kind of a chuck is the difficulty of keeping it clean and free from chips. It must be taken apart occasionally and washed in gasoline and brushed out, after which it can be re-assembled and oiled on the wearing surfaces. A few moments time is all that is necessary, however.

#### Vertical Turret Lathe and Boring Mill Fixtures

As the class of work which is usually handled on machines of this type is of a heavier variety, it naturally follows that the fixtures required are much more massive, and also that they must possess ample driving means, on account of the heavier cuts taken. As the fixtures lie flat on the table of the machine, the weight is of no particular importance, but rigidity and proper protection against chips must be carefully considered in the design. In addition to this it is well to remember that outlets for chips are also of importance, so that the latter can be brushed out. If some provision is not made for this, it will be necessary for the operator to scoop out the chips from time to time, and this is an unnecessary waste of time. Outlets can be nearly always be provided so that the matter will not be troublesome.

#### Special Jaws for a Large Motor Gear

The work *A* shown in Fig. 7 is a steel forging for an electric motor gear. Both the first and second settings of the pieces were accomplished on a vertical turret lathe; the operations were roughing cuts to within approximately  $\frac{1}{8}$  inch of the finished sizes. The blanks weighed something over 350 pounds and were rough-finished all over in these two settings, about eighty pounds of metal being removed. The blanks were composed of alloy steel containing a high proportion of carbon and manganese, thus making them very tough. The speeds used were about twenty to twenty-five feet per minute, and the feed from  $\frac{1}{16}$  to  $\frac{1}{8}$  inch per revolution. It will be seen from this that chuck jaws of the regular type would be put to their utmost capacity to hold the work without chance of slipping. A few of the blanks were machined in the regular type of jaw and there was more or less slippage of the work when the heavier cuts were being taken.

The method shown was suggested by the writer, but was not used on account of the few pieces to be handled at the time. The idea, however, is of some value. The two jaws *D* are of the regular type and are left set to form a sort of V-block arrangement for locating the work. The other two jaws *C* are of special design and are operated independently. Each of these jaws is fitted with a sub-jaw *H* sliding in a dovetail slot in the main jaw. This slot is cut at an angle of 15 degrees from the tangent to the work, and the jaw is kept in its normal position by means of the flat spring *J* which bears against it. The screw *K* holds the spring in place. The jaws are all provided with raised buttons on which the work rests. It may be readily seen that the pressure of the cutting tools would tend to move the piece in the direction indicated by the arrow at *F*, in case any slippage were to occur. Assume, then, that this takes place during the progress of the work; a wedging action would immediately begin at the points where these special jaws are, and this would prevent further slipping.

#### Large Spring Collet Chuck having a Floating Action

The flywheel casting shown at *A* in Fig. 8 represents a rather unusual condition, for the shoulder on the upper part of the hub is to be machined concentric with the tapered hole which has been machined in a previous setting. The rim, web and body of the hub are also to be machined in the second setting. A tool-steel, hardened and ground plug *E* fits the hole in the table and is a forced fit in the base *F* at *D*. The upper part of the stud is turned down at *C* to receive the sliding taper bushing *B* which is of the same taper on the outside as the hole in the hub. A coil spring supports the bushing and keeps it snugly in place in the hub. It will be noted that slight variations in the hole do not affect the locating, as the sliding movement of the taper bushing equalizes them. The base *F* is of cast iron and is fastened down by the three bolts *G* in the table T-slots. The upper portion *J* of the base is made of steel and is held down by the three special screws *H* which are fitted with clearance

enough to permit a slight radial movement or "float" to the plate, and at the same time act as drivers. Acme threads, 4 per inch, are cut on base *J* to engage the operating collar *R*. A thin steel taper ring is slotted in six places *N* and *O* in the same manner as that shown in Fig. 6, and driving pins *Q* are provided which engage the slots *P* in the ring. The operating ring *R* is of cast iron, tapered at *M* to fit the spring ring. It is revolved by a drill rod handle set into any of the holes *L* in the periphery. In using the device, the work is dropped down on the spring tapered plug, which automatically adjusts itself to the hole and allows the rim of the flywheel to rest on the flange of the spring ring. It is then only necessary to revolve the operating ring, which clamps the work securely, the floating action taking care of slight inaccuracies.

#### Arrangement for Holding a Piece of Thin Work

The thin steel casting shown at *A* in Fig. 9 was held in the first setting by the thin flange *L* in a set of hook-bolt jaws. (See MACHINERY, July, 1913.) During this setting the large diameter was machined both outside and inside, the inside of the web faced, and the hole through the web bored. In the second setting a cast-iron pot *J* is located on the table by means of the centering plug *K* which fits the center hole. This pot is used as a support for the work while facing and turning, and also locates the piece vertically. A set of jaws *B* is provided with hook-bolts *E* which are drawn up against the work on the inside by the nuts *G*. The soft steel sub-jaws are inserted in place and fastened by the screws *D*. These soft jaws are bored out to the correct size to fit the finished work and are brought up lightly against the casting before the hook-bolts are tightened. The screws *H* enter shoes which fit the T-slots in the table jaws. It will be noted that the soft jaws can be easily replaced, thus making the life of the main jaws almost unlimited.

#### Special Fixture for Holding Several Sizes of Bevel Gear Blanks

The work *A* in Fig. 10 is one of ten blanks, ranging in size from 12 to 20 inches in diameter, and the fixture shown was made to handle all these sizes, by the simple expedient of moving the main jaws to an approximately correct position and inserting a set of soft jaws which are then bored to the exact size of the outside of the ring. The body *C* of the fixture is located centrally on the table by the plug *H* which fits the fixture at *J*. The four bolts *G* hold the casting down on the table. Four T-slots are cut at *D* and the main jaws are clamped in their proper positions by bolts *E* which enter the shoes *F* in these slots. Approximate locations are determined for the jaws by the radial lines *T* scored on the finished pads. Both the main and sub jaws are of machine steel, the former pack-hardened and the latter left soft. The main jaws *B* are tongued on their lower sides to fit the slots. The soft jaws *P* are made up in a long strip and then sawed up into separate pieces. They are tongued at *R* to fit the main jaws and jig-drilled for the screws *Q* which hold them in place. The hook-bolts *K* are of tool steel, hardened and drawn to a blue on the hook end, to lessen the chance for breakage. The body *L* fits the hole in the jaw and the coil spring supports it. The stud *M* is screwed tightly into the jaw and is threaded at its upper end to receive nut *N*, which operates the hook-bolt. Attention is called to the manner in which the hook-bolts are backed up by the jaw, thus greatly stiffening the clamping arrangement. The backing is partially cut away at *S* to allow the hook-bolt to swing clear of the work. This fixture was made within the past year and gave excellent results at the time of testing.

\* \* \*

Some tests have recently been carried out at the works of Alfred Herbert, Ltd., of Coventry, England, to ascertain the comparative efficiency of ordinary and ball bearings for line-shafts. The tests showed that  $5\frac{1}{2}$  horsepower was required to turn over 62 feet length of  $2\frac{1}{2}$ -inch shafting, running without belts in seven adjustable self-oiling bearings, with two ring-rollers to each bearing. In the new factory of the company, where ball bearings are fitted to all the shafts, only  $2\frac{1}{2}$  horsepower was required to turn a shaft of the same length. On this shaft there were seven ball bearings placed at 10-foot intervals.

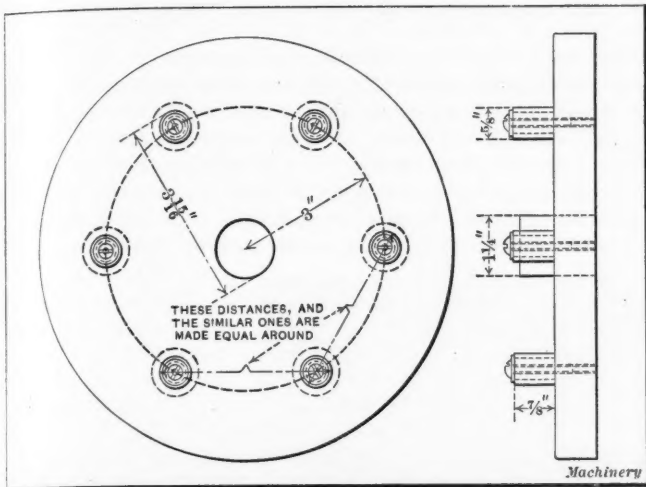


Fig. 1. Flange Templet showing Arrangement of Buttons

### LOCATING HOLES IN TEMPLAT PLATES BY THE BUTTON METHOD\*

BY D. DALTON†

The use of buttons for locating holes in templet plates, or bushings in drill jigs, is a very accurate method even when only a fair degree of care is taken in locating the buttons; and when considerable care is taken, it is the most accurate method and, sometimes, the only one which can be employed. The increasing use of multiple spindle drills in the machine shop calls more and more for the application of this method when locating the holes for the drill bushings.

#### The Buttons

The buttons are shown in the side view in Figs. 1 and 2. A convenient size is from  $\frac{1}{2}$  to  $\frac{5}{8}$  inch outside diameter, and from  $\frac{3}{8}$  to  $\frac{1}{2}$  inch inside diameter. If a No. 10, 24 threads per inch screw is used this will allow plenty of adjustment. The length should be from  $\frac{3}{4}$  to  $\frac{7}{8}$  inch; it is well to have the buttons a good length, so that the indicator can be used conveniently.

The buttons should be made of tool steel and hardened. They should be ground on the outside, and both ends should also be ground off square. Care must be taken to see that they are ground to exact size. A  $\frac{1}{2}$ -inch button must be 0.500 inch and not 0.499 or 0.501 inch, for these little errors cause considerable inaccuracy in the work. A set of buttons should be part of a toolmaker's kit.

#### Method of Using Buttons

Fig. 1 shows a templet plate which formed part of a fixture for drilling holes in flange plates. It was necessary to space the six holes equidistantly, so that the holes in the flanges would match up in any position and thus make the flanges interchangeable. First a plug was turned so that it fitted snugly in the  $\frac{1}{4}$ -inch hole in the center of the plate, and projected above the top about  $\frac{3}{4}$  inch. A center was located in this plug, and from this center a circle of 3 inches radius was drawn; around the circumference six divisions were laid off. Small 1-inch diameter circles were then

\* The following articles on this and kindred subjects have previously been published in MACHINERY: "Three-disk Method of Locating Holes," July, 1913; "Method of Accurately Locating Drilled Holes," May, 1913; "A New System for Locating Holes to be Bored on the Milling Machine," April, 1912; "Drill Jigs," January, 1907; "Drilling Jig Plates," October, 1902. See also MACHINERY's Reference Book No. 3, "Drill Jigs."

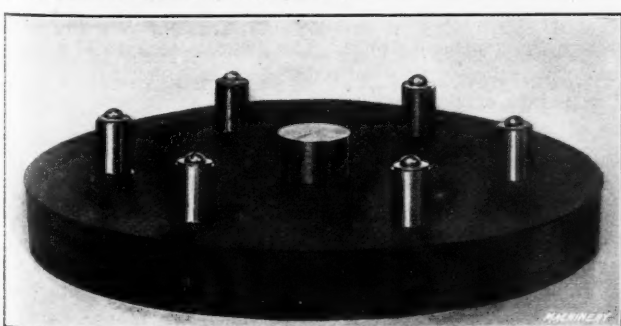


Fig. 3. Flange Templet shown in Fig. 1

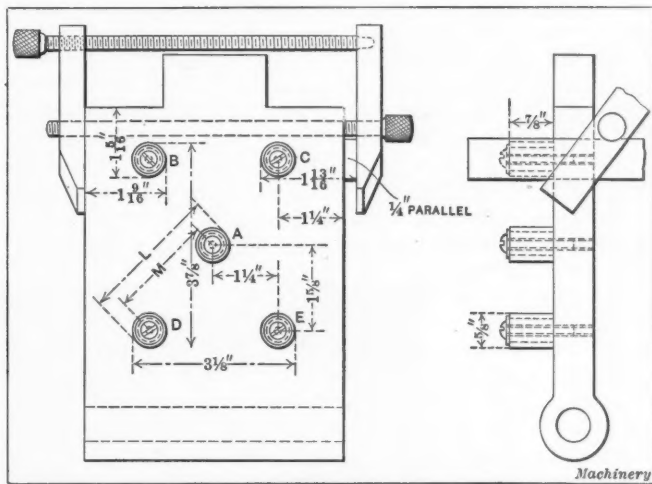


Fig. 2. Hinge Jig Templet

drawn at each of these points to indicate the outside circumferences of the bushings to be placed in the holes. These circles act as a guide when placing the buttons in position; they can be located much more quickly in this way.

The centers of the holes were next carefully prick-punched, and holes drilled and tapped for No. 10, 24 threads per inch machine screws. It is well to do this work carefully, so that the tapped holes are as near as possible in the exact center, as this will facilitate the starting of the boring of the holes for the bushings. Having now the six tapped holes around the circle, place a button at each point with a small washer on top, and fasten it approximately in the correct position; then tighten the screw sufficiently to hold the button firmly, but so as to allow it, at the same time, to be moved by tapping lightly. The radius of the circle being 3 inches, that of the plug  $\frac{5}{8}$  inch, and that of each button  $\frac{5}{16}$  inch, we find that the distance from the outside of the center plug to the outside of any button must be  $3 \frac{15}{16}$  inches. Also, since there are six buttons around the circle, the distance from center to center is equal to the radius, and the distance between the outside of any two buttons will be  $3 \frac{5}{8}$  inches.

We now have the distance each button should be from the center, and also the distance they should be apart. Then, by the use of micrometers, and by tapping the buttons gently all these distances can be correctly fixed. As each button is brought near to its correct position, it should be tightened down a little, so that it will finally be snugly located.

The work is next strapped on the faceplate of the lathe, and one of the buttons made to run true; this should be done accurately by means of an indicator. When the button is made to run true, the No. 10 machine screw may be loosened and the button removed. It will be found that in nearly all cases the small tapped hole will not be running true, and if a drill is used right away it will probably break off. A lathe tool can be used to cut away the front of the hole and so give a true start to the drill. This process is repeated for each button, and if care is exercised, the holes will be accurately located.

Fig. 2 shows a method of locating a button from the side of a plate. It will readily be seen from the illustration that the buttons B, C, D and E could not have been located with certainty from the center alone, for while they could have

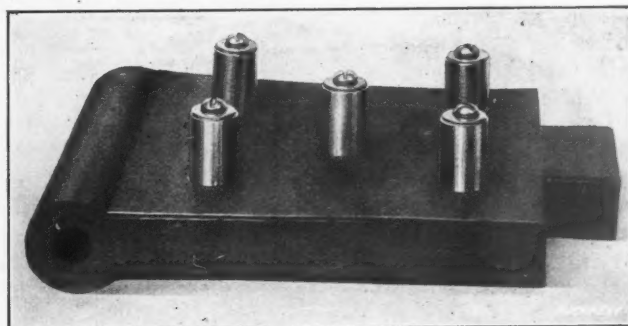


Fig. 4. Hinge Jig Templet shown in Fig. 2

been located the correct distance from the center, they probably would not have had their correct position with respect to the fixture as a whole. It was necessary, therefore, to work from the side and the center.

The width of the plate was carefully measured and found to be 5 inches; then, since the center to center distance of *B* and *C* was  $2\frac{1}{2}$  inches, that left  $1\frac{1}{4}$  inch from the center of *B*, *C*, *D* and *E* to the outside of the plate. A  $\frac{1}{4}$ -inch parallel was clamped against the side as shown in the illustration, and then the distance from the outside of each button to the outside of the parallel,  $1\frac{13}{16}$  inch, was used in conjunction with the distance *L*. Distance *L* was obtained by first solving for *M* by the use of the right-angle triangle, as follows:

$$M^2 = 1.25^2 + 1.625^2 \text{ or } M = \sqrt{1.25^2 + 1.625^2} = \sqrt{4.024}.$$

Therefore,  $M = 2.050$  inches, and  $L = 2.050 + 0.625 = 2.675$  inches.

In this case the center button was first located correctly from the sides and end, screwed down tightly, and not moved while the other buttons were being located.

\*\*\*

Steel passenger cars are built with double walls and insulation between. The insulation deadens the sound and acts as a non-conductor of heat, thus making the cars warmer in winter and cooler in summer than they would be without it. The application of the insulating material was formerly accomplished by attaching it to galvanized sheet steel strips with nails clinched. The strips were attached to the framing by stove bolts. The drilling of holes and placing of the bolts and strips was a slow, tedious and costly job. The

method has been displaced by a much simpler, cheaper and neater one that depends on the electric welding process. The car is placed in a circuit of 220 volts, the circuit being completed when the workman applies the head of a special nail to the steel side of the car. The nail is held in a pair of pliers provided with insulated handles and connected to the electric cable. The speed with which the nails can be welded to the car is very great and the cost of fixing the insulation in this way is reduced to about ten per cent of the old method. The insulation is applied by pressing it against the nails which penetrate it, and they are then clinched to hold it in place.

## HARDENING BOLTS BY THE TON

The best grade of carriage and machine bolts is made from a low carbon steel about 0.15 per cent carbon, low in sulphur and phosphorus. This steel, while it will not harden by heating and dipping in water, is made much tougher and its elastic limit considerably increased by the proper heat-treatment. In order to secure a uniform heat-treatment and to turn out large quantities of machine and carriage bolts, the National Screw & Tack Co., Cleveland, Ohio, has installed a

very interesting hardening equipment that is used for this purpose. Fig. 1 shows two of the furnaces used and gives a general idea of the method of handling the bolts when hardening, dipping and washing. The bolts, before being conveyed to the heat-treatment department, are sorted and all those of similar sizes and styles are placed in boxes, each box holding about 75 pounds. They are then conveyed to the heat-treatment department, piled up beside the entrance to the furnace, as illustrated in Fig. 2, and gradually fed through the furnace, which is of the drum type and kept in continuous rotation. The inside of this tubular furnace, which is from 10 to 12 feet long by  $3\frac{1}{2}$  to 4 feet in diameter, is lined with firebrick arranged in such a manner that a conveyor screw is formed by the convolutions of the firebrick. This drum is rotated by two friction rolls on one side, and rests on two rolls on the other side. The two friction rolls on the right-hand side of the furnace are driven by a shaft which, in turn, is driven through gear-

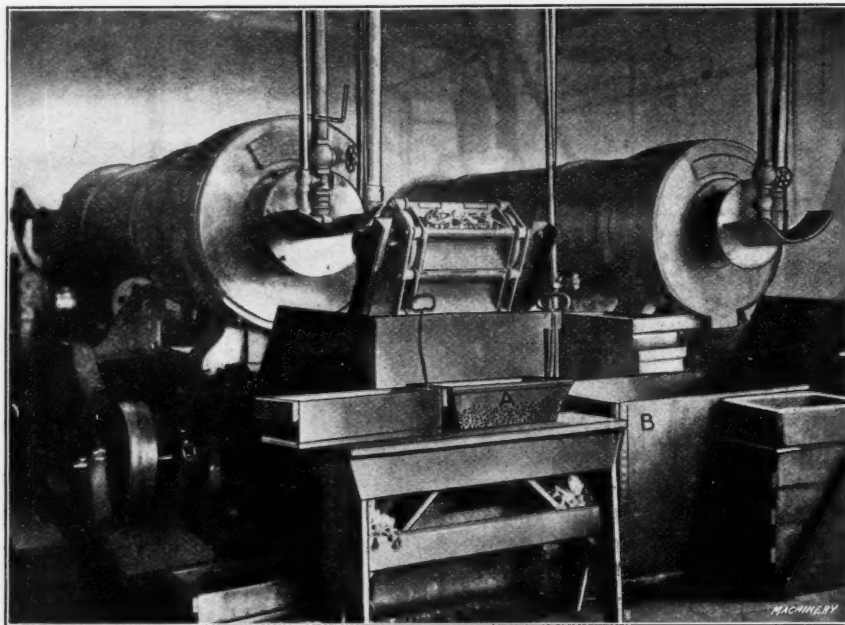


Fig. 1. Two Rotary Hardening Furnaces for heat-treating Carriage and Stove Bolts

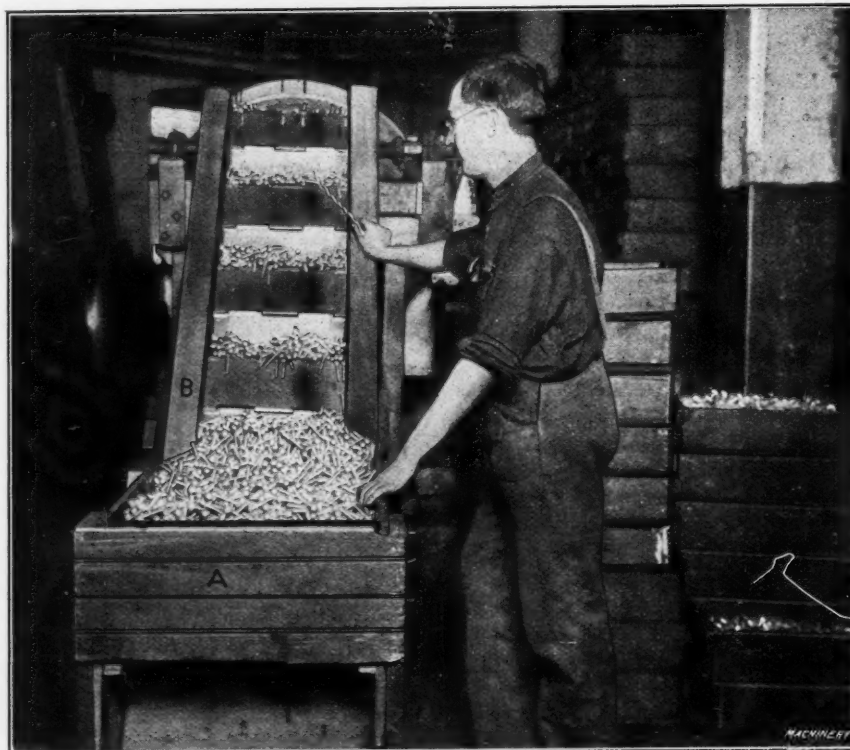


Fig. 2. The Feeding End of the Rotary Furnace, showing Conveyor Method of carrying Bolts from Boxes to Screw in Furnace Drum

ing from the overhead works. The drum is rotated at a speed of one revolution in fifty seconds.

The inside of the furnace is kept at a uniform temperature of about 1400 degrees F., by a burner which burns natural gas. The bolts are started through the furnace in the manner shown in the illustration Fig. 2. The operator dumps the bolts into the hopper *A*, through which a conveyor *B* is continually passing that is rotated through belting and gearing from the overhead works. This conveyor passes down the other side and deposits the bolts in a chute, through which they pass into the screw or conveyor in the furnace.

This screw gradually carries them toward the other end and in passing they are heated to a temperature of about 1400 degrees F. It requires eight minutes for them to pass through the inside of the furnace. The smaller the bolts, the greater the number that can pass through at one time. On carriage bolts,  $\frac{3}{8}$  inch diameter by 3 inches long, about 1180 pounds are hardened per hour. The furnace, of course, is kept working continually for twenty-four hours per day, as it would require a considerable time to get it up to the proper temperature after it had once cooled down.

As the bolts gradually work to the emptying end of the furnace, they drop out into a bath of water which is heated to a temperature of almost 212 degrees F., that is, it is kept boiling. This cools the bolts off slowly, does not harden them,

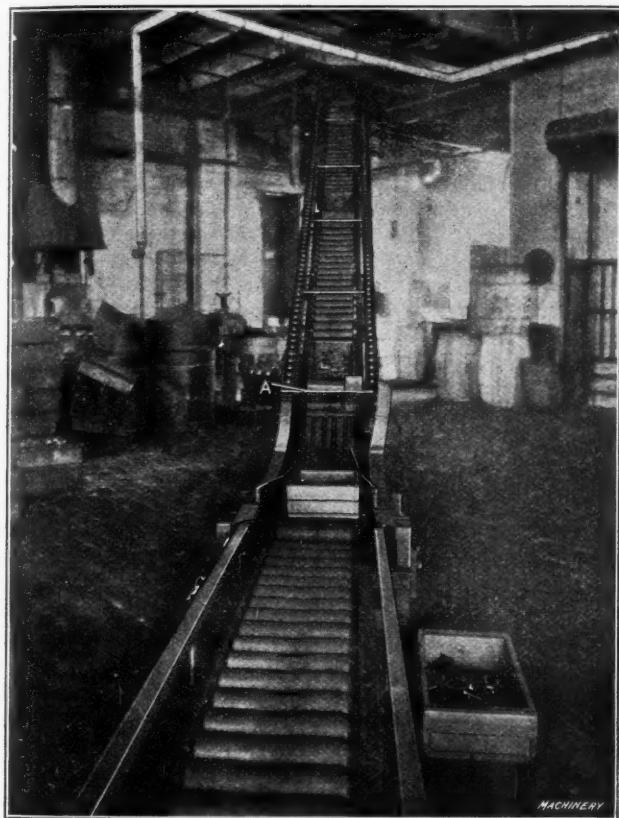


Fig. 3. Conveyor used in taking Boxes from Hardening Room to Packing and Shipping Departments

but just toughens them. The conveyor works through this bath, carries the bolts up again as illustrated in Fig. 1, and deposits them in a steel pan A. When this is almost filled, the operator removes it and drops it in the bath B, which is composed of soda and oil mixed with water. The bath is also steam heated and is used to give a good finish to the bolts after hardening; that is, it brightens the bolts and gives them a dark glossy coating. This soda and oil bath also makes the bolts rust-proof and gives them a very good looking finish.

After the bolts have been dipped in the bath as previously mentioned, the steel pan is removed, the bolts deposited from it into a wooden box and the box then placed on the escalator shown in Fig. 3. This, as can be seen, is arranged to take a box of the desired width, which it carries up to the next floor, and as each box passes the point A it operates the counter so that every box passing from the hardening department to the packing department is kept track of. This method of handling bolts reduces the manufacturing cost to a minimum, and what is more, a uniform heating and hardening effect is secured at almost no cost. On a bolt that is  $\frac{3}{8}$  inch in diameter by 3 inches long, a production of 28,320 pounds, or almost 13 tons, is secured in twenty-four hours.

D. T. H.

\* \* \*

Trials have been made in Germany to ascertain the possibility of using the oxy-acetylene torch for removing the scale in boilers. These are reported to have been successful. The deposit is immediately removed without injury to the plate.

## MANGANESE STEEL CASTINGS

Considerable secrecy has surrounded the making of manganese steel castings. Only a few concerns have been engaged in this industry and they have guarded the methods used with great care. In an article in the April number of *Foundry*, F. R. Zerhansen gives some information relating to the composition of manganese steel and the methods used in its production.

In making manganese steel castings, the metal is refined in a bessemer converter from which it is poured into a ladle in which the proper quantity of ferro-manganese has been previously placed. Either a standard bessemer or a tropenas or other modified type of converter may be used. The molding equipment is similar to that necessary for the production of unalloyed converter steel castings, and similar raw materials, including low phosphorus pig iron and selected steel scrap, are used. From a metallurgical standpoint there is nothing to prevent the successful production of manganese steel in open-hearth furnaces, and it is possible that there may be some developments in the future along this line, although at present the converter process is strictly adhered to.

The alloying material added is commercial, 80 per cent ferro-manganese, which is melted in crucibles in oil-burning furnaces. The quantity of manganese required varies somewhat with the nature of the castings, but 12.5 per cent is a good average figure. To produce castings that will show this amount of manganese upon analysis, it is necessary to add about 312 pounds of 80 per cent ferro-manganese to each net ton of steel. This is done, as previously stated, by placing the melted alloy in a hot ladle before the steel is poured from the converter. After the steel has been added to the alloy, the ladle is allowed to stand for a few minutes to permit the ferro-manganese to remove the oxygen and other gases and impurities from the metal, leaving it homogeneous and dense. The excessive accumulation of slag is then removed by skimming.

The shrinkage of the metal is unusually great, but otherwise the principles of ordinary steel foundry practice apply in making the patterns for manganese steel castings. The shrinkage amounts to  $\frac{5}{16}$  inch per foot. Ordinary steel shrinks only about  $\frac{3}{16}$  inch. Patterns, therefore, must be specially made for this material, as otherwise the castings will be under size. Abrupt changes in section are more objectionable with this steel than with other kinds. The molds must be made from sand containing a high percentage of silica, and are usually oven-dried, although in some cases skin-drying is sufficient.

Manganese steel castings are generally allowed to cool in the mold and are then annealed from three to twenty-six hours at temperatures ranging from 1800 to 2000 degrees F. At the conclusion of this process, they are removed red-hot from the annealing oven and are quenched suddenly in cold water. Some castings, however, need a preliminary treatment to remove cooling strains, and in this case they are taken from the sand while still hot and slowly cooled in an oven, after which they are reheated for annealing and quenching as described.

Unannealed manganese steel castings are exceptionally brittle and almost glass hard. After the heat-treatment, they are tough and ductile with a tensile strength of about 90,000 pounds and an elastic limit of about 60,000 pounds per square inch. The ductility of the metal is indicated by the elongation and reduction of area, frequently amounting to about 28 and 29 per cent, respectively. It is possible to satisfactorily anneal manganese steel castings having a thickness up to about  $5\frac{1}{2}$  inches. After the castings are annealed, they are cleaned and finished on grinders. Castings which must be accurately finished to given dimensions cannot be machined by ordinary methods on account of their toughness, but must be ground to size.

\* \* \*

A boiler inspector in the middle west writes: "Farm hands would be more numerous here if this state had an engineer's license law, it occurs to me."

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# MACHINERY

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## ON SETTING UP MACHINE TOOLS

Probably the builders of machine tools in general receive more complaints that are due to the fault of the purchasers than other machinery builders. The reason is that lathes, planers, boring mills and other machines of precision must be set level on even foundations in order to produce accurate work. A slight twist in a lathe bed will prevent it turning or boring straight. The user must set his machine up properly in order to obtain satisfaction. Not many machine tool builders, however, have as exasperating an experience as one whose machine was set on a foundation covered with rust cement.

Rust cement composed of iron borings and sal-ammoniac was much used in the early days of engineering in the construction and erection of machinery. A foundation covered with this cement might have been good when machines were small and not over-accurate, but today it is a different matter. This machine tool builder had furnished a boring mill to a customer who was very particular as to the accuracy of the work produced. The machine was shipped and set up, and after it had been in use a few days an urgent letter of complaint was received, stating that it was boring a taper hole and requesting that a man be sent to correct the fault.

The superintendent went to the plant and looked the machine over, including the foundation. When he saw that the purchaser had set the mill on rust cement he immediately suspected that the cause of the trouble was the slow expansion of the cement due to the rusting process, but could not convince the purchaser that this could be the cause. The table was lifted and the track scraped a little, the wedges under the machine readjusted, when the machine bored a perfect hole. In a week another complaint was received and again the superintendent went and corrected the fault. He again told the purchaser that the cause was the lifting action of the cement but was not believed. A third time was this episode repeated and then the purchaser was induced to remove the rust cement and float in a grout of hydraulic cement. This stopped the trouble as the superintendent had predicted.

It hardly seems necessary to say that any medium underneath a machine likely to change is undesirable. Ordinary cement is cheap, easily obtained and can be depended on to maintain its integrity under normal shop conditions.

## EFFICIENT JIG DESIGN

A walk through many American manufacturing plants will demonstrate to one familiar with the best machine shop methods that there is still much to be done in cutting out useless and time-wasting movements. The superintendent who has to provide equipment for producing a comparatively small number of parts is likely to order jigs and fixtures made as simply as possible. This usually means primitive clamping devices—nuts and bolts, for example. Often these clamps are inconveniently placed and the operator loses time in making many unnecessary movements.

Now it does not require a highly trained efficiency expert to avoid such mistakes. Applied common sense is the secret of good engineering, whether it be the building of a jig or a great bridge. Both the jig and the bridge are but means to secure an end. A toolmaker can generally make a simple fixture convenient to use as easily and quickly as an unhandy trap. The first is efficient, the second may be a time-waster to such a degree as to be a costly device before worn out or superseded.

In general, a jig should be self-contained, requiring no detached parts or wrenches for operation. If, in addition to a wrench, a hammer must be used to set up the clamp firmly, it is a poor device.

\* \* \*

## BALANCED DRILL CHUCKS

A manufacturer of a very good sensitive drilling machine running at the usual range of speeds had been using a standard line of drill chucks for a good many years with satisfaction. Recently he developed a high-speed drilling machine operating at several thousand revolutions per minute. His concern prided itself on the good work it did in aligning its spindle bearings and every spindle was tested for alignment before leaving the factory. When the new type of machine was first operated, he applied chucks of the usual type, but found that under the high speed the spindles ran out considerably. With the drill chucks removed, the spindles ran perfectly true again, showing that the trouble lay in the drill chucks themselves. Out of a lot of fifty chucks, only three were found to run in balance at high speed. In a word, the chucks that ran satisfactorily at 1000 R. P. M. ran out badly at speeds of from 5000 to 10,000 R. P. M.

The chuck manufacturer when called in to examine the machine learned a new lesson in chuck requirements, and on the next lot of chucks special care was taken that the individual parts were balanced, the result being that no more trouble has developed from this source. The balancing of chucks for use on high-speed machines is highly important, though a point usually overlooked by machine builder and chuck maker alike.

\* \* \*

## AFTER THE MACHINE HAS BEEN SHIPPED

Not many hundred miles from New York City there is a manufacturing concern making a special machine which performs but one very simple operation—so simple that in the minds of the builders there could be no cause for complaint about its performance. In fact, they had been building the machine for years without receiving serious criticism.

Recently, a friend of the manager of this company, whose work takes him into many shops where the machine is in use, pointed out that whenever he saw one of these machines he noticed invariably that one of its bearings was kept covered with a heavy piece of paper tied on with a string. In every case this piece of paper was oil-soaked, so the visitor rightly concluded that the paper was to stop the spattering of oil from this bearing. The factory manager saw the point immediately, and the result will be a change in the design of this part of the machine.

The moral to this little incident is that no matter how simple a machine or specialty may be it is to a manufacturer's interest to follow his machines to the place where they are operating. An occasional trip around the trade to see how his product is working out will benefit him, his machine and the general users of his product.

## HOMEMADE SCIENTIFIC MANAGEMENT

When "efficiency engineers" are employed to introduce methods of scientific management in a factory, their work is usually hampered by opposition from the employees. It is only natural for foremen and mechanics who have spent a number of years in acquiring a knowledge of the methods used in their work to feel that they are more familiar with the practical details than the so-called "efficiency experts" who are called in to improve them. The result often is that the men in the shop give little or no assistance to the efficiency engineers; but are rather inclined to throw obstacles in their way. This means that the engineers must spend a considerable amount of their own time and their client's money in cultivating the good will of the factory staff before they are able to get down to actual work.

Scientific management has been aptly defined as "the application of common sense in manufacturing methods with the view of increasing efficiency." The name sounds formidable, but the methods are often very simple. In most cases, efficiency engineers are called in to increase production rather than to improve the quality of the work; and their services are needed because the factory staff has devised carefully thought out ways and means for producing work of the required perfection, but has depended largely upon physical effort to keep the rate of production up to a satisfactory standard. The importance of eliminating lost motion and useless effort in turning out the maximum amount of product for a standard day's work has not been appreciated. This is what the efficiency engineer strives to do.

In efficiency engineering, as in other fields, experience is of value; but while the efficiency engineer may produce satisfactory results with his knowledge of general conditions, he is likely to fail through lack of specific information concerning the industry in which he is temporarily engaged. This lack of specific information often leads the efficiency engineer to recommend methods which he has applied successfully in one line of work, but which may prove a complete failure in another line because they conflict with existing conditions which have been overlooked. Men who have spent years in learning the details of one particular kind of work are naturally familiar with the practical conditions governing its production, and if such men could be taught to undertake the development of plans for increasing efficiency, there would be little danger of failure on account of their methods being unsuitable for the purpose for which they were intended.

One of the greatest drawbacks in the departmental method of factory administration is that it is responsible for killing ambition among the employees in a shop. Men are hired to run a drill press, milling machine or other tool and are kept on such work continuously, with the result that they lose interest and fail to develop the initiative which will fit them for more advanced positions. Any plan that can be adopted to remedy this difficulty directly benefits both the employer and the employee, and it appears that "homemade" methods of scientific management could be developed in this connection to very good advantage.

Some men in a shop have good ideas in regard to methods of reducing production costs, but diffidence prevents them from placing such ideas before the management. Other men are capable of developing valuable ideas, but lack incentive. Both of these classes could be reached by using a suggestion box in connection with some effective method of reward. In the case of shops working on a bonus system, the interests of employer and employee are both benefited by any method which increases efficiency, so that in such shops the necessary incentive already exists. In other cases, the reward might take the form of cash prizes for ideas of sufficient merit to be used in the factory, or—better still—a record of useful ideas submitted by each man might be preserved in the office and this record made the basis of promotion. The application of this system would be the direct means of counteracting the effect of the departmental method of manufacture in killing ambition among the men in the shop.

\* \* \*

The most effective safety appliance yet discovered is a careful man.

## EXPORT AND IMPORT TRADE\*

BY G. S.

Having been engaged in the export and import business both here and abroad for the last twelve years, I am almost daily confronted with questions from American manufacturers concerning the possibilities of exporting American manufactured goods to foreign countries in all parts of the world. With the present changes in tariff and the new democratic administration, this question of "export" has become more prominent than heretofore, and has attracted even the attention of the general public. A few remarks dealing with the fundamental principles of exporting are therefore quite timely.

It is a striking fact that whenever an American business man mentions export to foreign countries a considerable change takes place in his general attitude. No matter how confident and self reliant he may be about his business ability at home, his splendid system and organization, his up-to-date manufacturing methods, his efficiency, etc., his confidence in himself and the whole American nation seems to fail when it comes to the question of export. "Well," said one prominent American to me a few days ago, "look at the Germans; they are better business men than we, they are doing an export trade of manufactured goods to every little corner of the world. Why it is preposterous to think that even in countries like the Philippines, Cuba and the South American Republics, we depend on the German export houses to handle our own goods." Some blame it on the government; others attribute it to the fact that the young American has no liking for absorbing foreign languages.

Neither is the true cause. I venture to state at the outset that the average business man in America is at least equally, if not more progressive in all branches of business than his German or English cousin. The reason that his export trade is not developed in the same high degree is due to quite natural circumstances; in fact, it is due to an almost insurmountable natural law, as I will try to explain in the following.

I will begin with an explanation of the meaning of the word "export." Usually, for the manufacturer who has done no export business at all, or only a little occasionally, the word export has quite a charm. He pictures in his mind an order mailed to him from a foreign country with a strange looking envelope, stamp and order sheet. When he has that order, all that is left to do is box up the goods, follow shipping instructions on the order sheet, and collect money in New York by means of draft attached to bill of lading. No trouble at all, not even as much as is sometimes experienced at home when furnishing machines to a neighbor, where the superintendent is "the best mechanic in the country." Unquestionably, it is a desirable business with no expense attached, to speak of; and as a general rule, I must admit that the American manufacturer is very exacting about carrying out instructions properly, and boxing and carefully inspecting the goods he sends out into foreign countries. He is proud to do an export business. But the word "export" has an incomplete meaning; in fact, it signifies only half or third of the entire transaction. The other half is the word "import." That is to say, the foreign country to which the machine is shipped is importing it. Therefore the whole word should be "export-import." But this import part of the transaction rarely receives any consideration whatever; usually the manufacturer does not even know the name of the importer on the other side of the ocean, and is not interested in his general welfare after the goods are shipped and paid for. Here is one point at which the American business man can develop more action. If the prospects for selling many machines are not sufficiently large to warrant the expense of a personal visit, write your importer from time to time, calling attention to improvements made in construction; write him about the talking points of the machine; give him examples of production and examples of application to new lines of business. In short, teach him by mail how to handle your

\* For additional information on export trade and allied subjects, see "Packing Machine Tools for Export" published in MACHINERY for February, 1909, and "Packing Machinery for Export," July, 1909.

line of goods the same as you would instruct one of your agents or traveling salesmen at home.

In case your line of goods has good selling possibilities in foreign countries on account of patent protection or superior features of either quality or lower price, a personal visit to your importer from time to time is by all means desirable. Do not hesitate to go because you cannot speak a foreign language. Your importer will speak English. It is part of his vocation to speak a few foreign languages, the same as you must know something about a planer even though you build a lathe. When there, convince yourself that your importer is the right representative for you; that he has the facilities to cover the country and the means to finance his deals. Importers have to give credit to their customers, and if your man is limited in capital, he will be limited in accepting orders.

After being fully convinced about these matters, do not leave your importer until you have injected into him and his salesman an enthusiasm about your machine, the same as you have yourself. Assist him wherever you can; consider carefully his suggestions; make changes, if required, to suit the particular wishes of the user. Do not think that if you sell it that way in the United States, it is good enough for other countries. Other people think differently from you, and you will have neither the chance nor the time to educate the importer and his staff after you have left. On the prices for export business do not figure all your overhead expenses and domestic advertising and selling expenses. Consider that your importer has to advertise and sell on his own account, and that he has to add his expense to his cost. No importer can expect to stay in business with 10 or 15 per cent commission and be successful, any more than you could be if you were to add 10 to 15 per cent to the actual manufacturing cost of a machine, and cover with this the salaries of your office force, salesmen, traveling, advertising expense, etc.

Anything more that I could offer in the way of suggestions would be details into which I do not intend to go at this writing. I will therefore answer now the question, "Why do we Americans mostly depend on foreigners to sell our goods even in countries like the Philippines, Cuba, Argentine, etc." As already indicated at the beginning of this article, the cause is a natural consequence of a natural law. Let us suppose that, starting from tomorrow, the American people would begin to teach foreign languages in public schools and succeed in making excellent linguists out of their youngsters. Would the export trade of the United States improve, and would the Americans do the business themselves? The answer is, "No." There would be, perhaps, other things being equal, a small increase in business due to a little more interest; but the majority of the business would still be done through foreign import houses, principally English and German. Why this is so is very simple indeed. There are almost no American born importers in foreign countries, and their number is not expected to increase in the near future. The young American is not going to foreign countries to work and be satisfied for any length of time.

By way of contrast, take as an example the German nation. You will find its representatives in every country in the world, even on the littlest island in the South Sea. These Germans, however, did not originally go there because they intended to make the Fatherland great by building up a large export for Germany. They went because they could earn more money and afford a higher standard of living there than at home. The Italian may go to Germany, the German to England, the English to the United States, but the American will stay at home. There is no country for him where he can earn more money (a few specialists or experts are paid high salaries) or get a higher standard of living. The stream is never flowing in the opposite direction. Take the conditions within the boundaries of our own country. If in Rochester, N. Y., a young mechanic is paid 30 cents an hour, and he reads that in Detroit the wage for his kind of work is 50 cents an hour guaranteed, and lots of people are in demand, he will pack up some day and go to Detroit. A farmer in the east, if he hears that raising corn

is easier and more profitable in the west, will move some day. This is the natural order of things. English and German people have early begun to go to foreign countries, and they are now established and acquainted with conditions. Their governments have ably assisted them in every way, by means of brains and power.

If the voluntary emigration of German or English people becomes less, because of better wages and an improved standard of living at home, the established merchants will make efforts to get them by promising an even better salary than they are getting at home. If the merchant cannot afford to pay more, the business will in time pass into the hands of the natives or the representatives of some other nation. If, on account of the new democratic regime, the United States' scale of wages should decrease and the standard of living become lower than in any other country, the young American, the same as the citizen of any other nation, would begin to emigrate to foreign countries. He would, the same as others, be satisfied with his better wage for 3, 5 or 10 years, as an employe for another firm, then establish himself as an importer.

As the matter stands now, I believe Americans have no reason to desire the emigration of their young people, if it would have to be at the sacrifice of the present high standard of living and good wages for everyone. Americans can increase their export trade by getting in touch with established export houses, regardless of what nationality the owners are. Importers are business men in the strictest sense and do not know any feeling of antagonism against any other nation, no matter what the newspapers write to the contrary.

\* \* \*

#### MATERIAL IN CAST-IRON FLYWHEELS

Attention is called in *The Travelers' Standard* to the danger of using cast iron containing too much phosphorus for flywheels and pulleys. Flywheels sometimes burst, without any apparent cause, at low speed, the running conditions being normal at the time of the accident. When the material is examined, it may be that no defects can be discovered on the fractured surfaces, and that no cracks, blow-holes, nor discolorations can be found. Furthermore, when the fractured parts of the wheel are tested for strength, there is often no physical evidence of inferiority in the material.

An accident may sometimes result from internal stresses in the material, due to faulty design or to careless cooling of the casting; but severe internal stresses seldom occur except in wheels made in one piece. Some other explanation must therefore be sought for accidents of this nature, and the cause will often be found to be the use of improper raw material in the foundry. Chemical analysis frequently shows that the iron is not of a grade suitable for machine castings. This is particularly likely to be the case in wheels from small foundries that turn out all kinds of work, because in such places the same grade of raw material is likely to be used for castings of all kinds. A considerable part of the output of a foundry of this sort requires metal that will flow freely, so as to fill the forms well. In making ornamental work, for example, it is highly important to obtain a sharp impression. Such iron invariably contains a large percentage of phosphorus. Phosphorus lowers the melting point, but makes the iron brittle; and machine castings should never contain more than 0.4 per cent of it.

There is on record a case where a pulley burst under ordinary running conditions, and where no defects could be discovered in the broken wheel by a visual examination; but an analysis of the iron showed that it contained 1.37 per cent of phosphorus, or nearly  $3\frac{1}{2}$  times the maximum that should have been allowed. There is little doubt but that brittleness of the metal, due to this high percentage of phosphorus, was the cause of the break. From a safety point of view, it is exceedingly important to make cast-iron wheels of material with a low percentage of phosphorus.

\* \* \*

Don't forget when drilling a hole on an angle, that the drill is going to come through on one side of the work first, and that care should be taken to let it through carefully or it is likely to be broken.

## PRESSED VS. MACHINE FINISHED PARTS

BY P. O. URBANI-PUSCHMANN

In the manufacture of interchangeable parts such as are used in the assembly of adding and addressing machines, registers, scales, typewriters, etc., a large quantity of duplicate pieces of a tubular or hollow cylindrical form are used. These must not only be absolutely concentric but interchangeable and yet low in production cost; hence it becomes quite a problem for the shop superintendent to decide which is the

parallel to its axis, and Fig. 2 (View A) shows a slotted filler for this shaft. Fig. 1 (View C) shows a spacer tube, and Fig. 3 (View A) illustrates a threaded housing for a ball race.

After a superficial examination of these illustrations, nearly every practical man would assign these parts to the screw machine for the first operation, to be followed, where required, by a slotting operation on the milling machine. The fact is that these parts have been made for years in just this way in our factory until we realized that they were costing considerably more than their allotted allowance in the as-

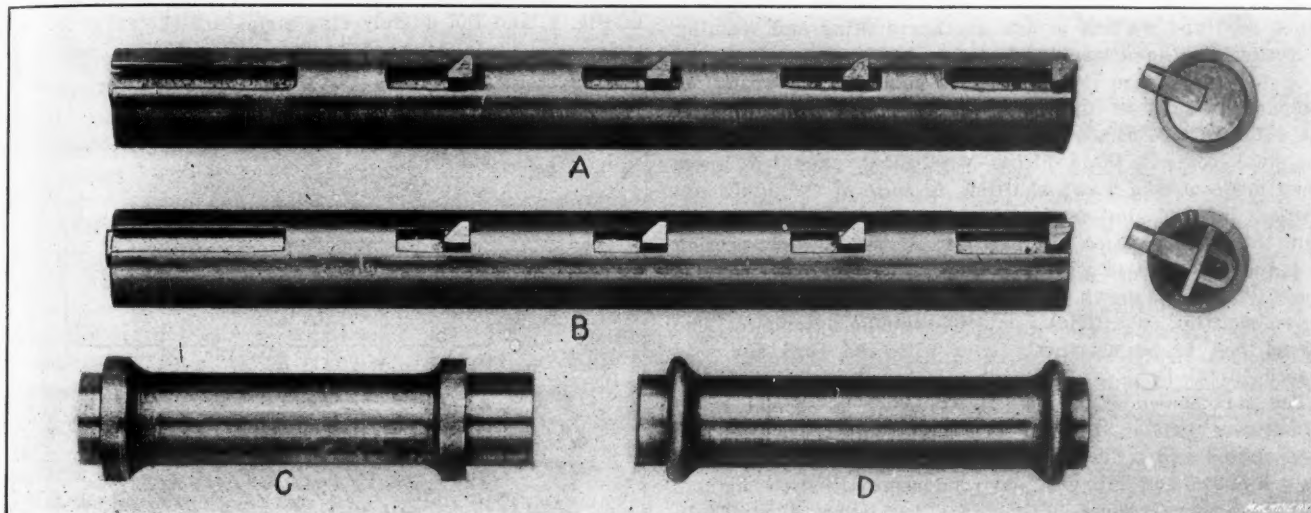


Fig. 1. (A) Part machined from Bar; (B) Same Part produced from Sheet Steel in Dies; (C) Machined Spacer Tube; (D) Die-formed Spacer Tube

best, quickest and cheapest way to produce such parts. If the quantities required are small, say not over one thousand pieces per lot, and the lots are far between, and if cheapness need not be a prime factor in his calculation, the superintendent will invariably decide in favor of screw machines, either automatic or hand operated. The percentage of perfect or interchangeable parts that will be obtained from a

assembly of the machines. On account of the very close limits on length and concentricity of the outside with the hole, the inspection loss had been very great and the time of production slow, so that the screw machines fell behind with other work. This necessitated working overtime and employing night shifts at higher wages, which meant an increase of pay roll, an increase of power and light bills and raised our entire overhead charge, affecting directly the production cost of the screw machine department in total.

The parts shown at A and C, Fig. 1, were first made of seamless steel tubing of sufficient wall thickness to allow machining the pieces both inside and outside. The hole was first bored and reamed to size, but since tubing having such a wall thickness could not be secured absolutely true and the drill and reamer followed the old hole subject to the law of least resistance, we could not get concentric work until we finished the outside surface by a later operation. This was done by driving the pieces on arbors and turning them between collet and center. By this method the work was made true, but the finish depended, of course, on the sharpness of

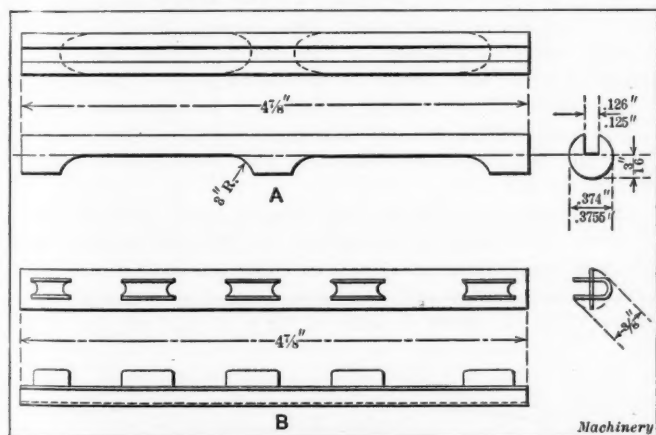


Fig. 2. (A) Slotted Rod for Hollow Shaft shown at A, Fig. 1; (B) New Method of producing Part to replace Solid Rod A

given lot depends largely upon the condition of these machine tools, the skill of their operators and the stringency of the inspection limits.

Another reason why screw machines are generally favored for this class of work is because of their adaptability to various forms of cylindrical work without a great investment for special tools, except a nominal figure for forming tools and reamers. This factor is perhaps the trap in which many otherwise shrewd shop managers are caught, because they see only the low initial cost for tools and overlook entirely the loss per lot due to slow production, to work spoiled or not passing inspection, and the fact that their screw machine department becomes overtaxed with work that could be done advantageously with special tools in punch presses or special machinery. Therefore they deprive themselves of the use of their screw machines and milling machines for work that cannot be done to advantage in any other way.

The accompanying illustrations show examples of work which will illustrate the idea referred to in the foregoing. Fig. 1 (View A) represents a hollow shaft with slots running

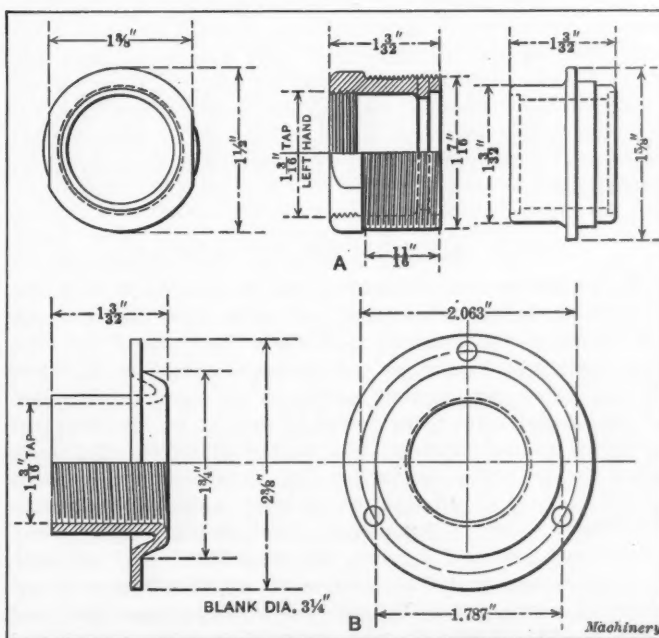


Fig. 3. (A) Ball Race Housing machined in Gridley Automatic; (B) Ball Race Housing pressed from Sheet Steel

the cutting tools and the cutting speed of the machine. Anybody acquainted with machining unpickled steel tubing knows what that means.

Finding this method unsatisfactory we changed the material and made the parts of cold-drawn steel shafting of the largest diameter of the finished pieces, depending upon the accuracy of the stock for the outside surface, the size of the reamer and copious lubrication for the size and smoothness of the bore, and on good luck for the truth with which the drill and reamer would come out on the other end, or rather meet in the center, inasmuch as our automatics have only a 2-inch feed and we had to add another drilling and reaming operation on a hand machine.

On account of the lower price for cold-drawn shafting, as compared with steel tubing, and because the machining of the outer surface of the hollow shaft A, Fig. 1, was omitted, the final cost of these pieces was about one-third lower when made of cold-drawn shafting, in spite of the additional drilling through the center. However, even at this reduction, the price was too high because of the large inspection loss due to eccentric work, as well as to rough or oversize holes. The part shown at A, Fig. 3, was also made of cold-drawn shafting on a Gridley multiple-spindle automatic. The thread had to be absolutely true with the bore and was chased on the lathe.

The part shown at A, Fig. 2, was made of special gaged cold-drawn shafting, cut off on a hand screw machine and then slotted and milled, at great expense, in two operations. View B shows how this part was produced by the new method. The appearance is somewhat modified, but it serves the identical purpose. In manufacturing this part by the new method we finally dispensed altogether with the expensive and unreliable screw machine and milling operations, leaving these machines available for other jobs, thus avoiding the expense of overtime and night work and, incidentally, reducing the cost of the products to a surprising extent.

All of these parts, with the exception of the one shown at D, Fig. 1 (which is die-formed of seamless steel tubing of a gage to give the correct diameter at the shoulders and requiring no machining or finishing) are now formed of cold-rolled open-hearth sheet steel in special dies and require either no machining or very little. In spite of their great cheapness, the pressed products are far more satisfactory, uniform, and, therefore, interchangeable, than the expensive machined pieces were. An added advantage of the pressed pieces is their smoothness and wearing qualities due to the rolled surface of the raw material. To produce these pieces from cold-rolled sheet steel, instead of from bar steel in the screw machines, required an investment of about five hundred dollars, but the saving on the first lots repaid for this expenditure and left a profit besides.

The examples referred to in the preceding, while based on facts, are by no means suggested as a criterion by which other conditions should be regulated. They merely indicate one man's opinion and illustrate how we dealt with perplexing conditions and remedied them to our entire satisfaction. If this article has suggested ways and means by which others confronted with similar troubles will be benefited, it has served its purpose.

\* \* \*

#### COAL RESOURCES OF CANADA

From time to time sensational writers hold up to view the horrors of the conditions that will arise when the fuel supply of the world gives out, and many have placed the time when this will happen as only about a couple of centuries distant. However, as time passes on an increasing number of coal deposits are being found in districts at the time not suspected as coal bearing. The Geological Survey of Canada gives the following figures for the actually known deposits of coal in the province of Alberta alone: Anthracite, 668,000,000 tons; bituminous, 3,200,000,000 tons; semi-bituminous coal and lignites, 385,000,000,000 tons. In addition, there are *probable* deposits of 100,000,000 tons of anthracite; nearly 200,000,000,000 tons of bituminous coal; and close to 500,000,000,000 tons of semi-bituminous coal and lignites.

#### RENEWING DUMMY AND GLAND STRIPS IN A PARSONS STEAM TURBINE\*

BY N. I. MOSHER†

The method of renewing the dummy and gland strips in a Parsons steam turbine presented in this article outlines the shop practice of the Boston Navy Yard, and a method of procedure is also described which can be followed with satisfactory results when it is not convenient to dismantle the turbine and send it to the shop for repairs. Part of the section of the rotor with the dummy rings is shown at A in Fig. 1, and the dummy ring strips are shown at B. The strips are made of hard bronze and act as a baffle and

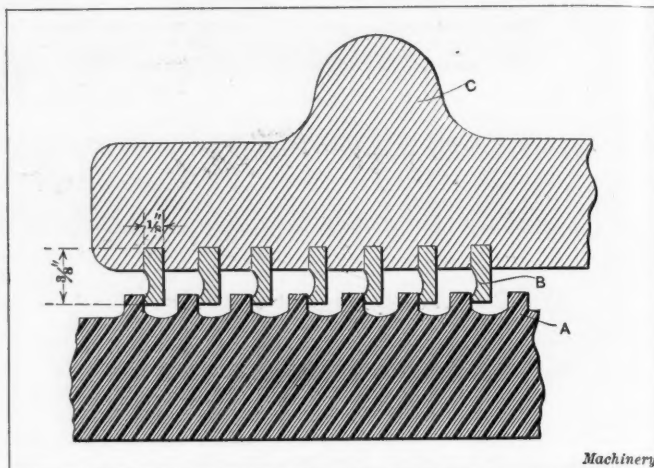


Fig. 1. Arrangement of the Gland Case Dummy Ring Strips and Dummy Rings

packing between the revolving rotor and the fixed cases. These dummy strips become worn from unequal expansion between the cases and rotor or from improper thrust adjustment, causing the strips to rub against the dummy rings. The adjustment between the dummy rings and the strips is ordinarily 0.012 inch. By the proper manipulation of a micrometer instrument, the correct location of the dummy rings in relation to the dummy strips can be determined while the turbine is in motion with a great degree of accuracy. The turbine considered in this article has thirty rings, which are cut into the rotor to a depth of  $3/16$  inch, and the rings are  $3/16$  inch wide on the steam entering end of the rotor.

The dummy ring strips are secured in a casting, which, in turn, is secured to the inside end of the turbine cases and machined diametrically true from the axis of the journals. These strips are 4 inches long and rectangular in shape. Fig. 2 shows a detailed view of one of the strips.



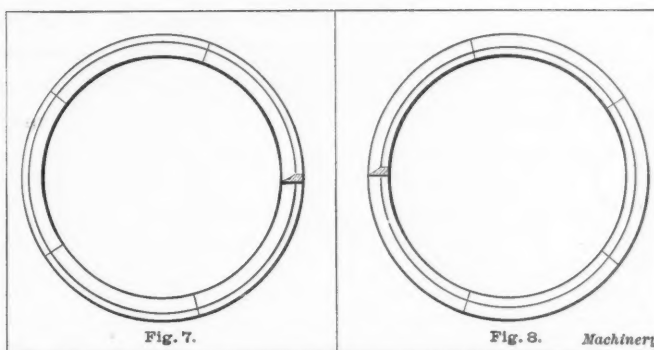
Fig. 2. Detail of one of the Finished Dummy Ring Strips

The following method of renewing these strips was adopted. Standard plates of bronze 24 by 48 inches in size were sawed into strips 4 inches wide, making eleven pieces 24 inches long by 4 inches wide. Eight of these pieces were next secured to the boring mill platen, running out radially from the center. Then a tool was forged and its end machined to the desired shape, as shown in Fig. 3; and the toolholder was moved the required distance on the rail to give a diameter of  $31 \frac{3}{16}$  inches. The tool was then fed down into the revolving pieces on the boring mill platen, forming and cutting off eight of the required shaped strips. With the tool remaining in its original position, and by simply unstrapping the brass plates and moving them out the required distance, another set of eight strips was cut off, and so on until the plates were entirely cut up. This method wastes very little stock and the operator can easily cut 150 pieces in eight hours.

\* For additional information on this subject, see "Re-blading a Parsons Steam Turbine" published in the December, 1913, number of MACHINERY.  
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The variation in the thickness of the bronze plates was found to be from 0.001 to 0.007 inch, and to overcome this a sizing die was made which sheared the pieces all to one thickness, namely, 0.125 inch. This completed the machining operations, leaving the pieces finished all over to the proper thickness and diameter. The grooves in the gland casing *C*, Fig. 1, were approximately 0.123 inch wide, or just enough smaller to afford a snug driving fit when the finished strips were forced into them. For performing this operation, a set was machined to the same radius and length as the dummy strips, as shown in Fig. 4. These strips are set about 0.012 inch apart to allow for expansion. After having the 600 strips forced into the grooves, a set was used to calk the metal and fasten the strips more securely.

Having completed the dummy strips, we now turn to the gland strips. Fig. 6 shows the rotor spindle strips and the gland strip casing and strips. It will be noticed that the gland strips are of a different design (see Figs. 7 and 8) from the dummy strips. The edges are machined to a knife edge and the spindle strips just touch the inside of the case that supports the fixed strips; the fixed strips, in turn, just touch the spindle, less a clearance of 0.002 inch. The material for the gland strips is purchased from the mills in rectangular shaped pieces  $\frac{1}{8}$  by  $\frac{3}{8}$  inch in size, rolled up in coils about the diameter of the spindle and the gland



Figs. 7 and 8. Fixed Gland Rings and Spindle Gland Rings

able from the main turbine case and can be set up in halves on either a horizontal or a vertical boring mill, enabling the machining operation to be performed very satisfactorily. The operation on the spindle is purely a lathe job.

The preceding paragraphs describe the method followed when a turbine rotor and cases are delivered to the shop. When the work is to be done on board ship, however, without the use of a full equipment of power-driven tools, the following operations are required: First, cut the gland strip stock,  $\frac{1}{8}$  by  $\frac{3}{8}$  inch in size, into rings of the proper di-

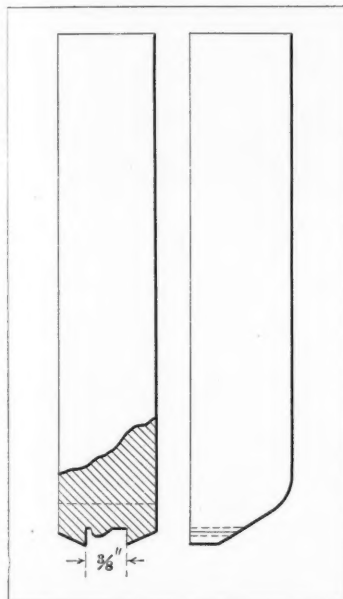


Fig. 3. Tool used for machining the strips in the boring mill

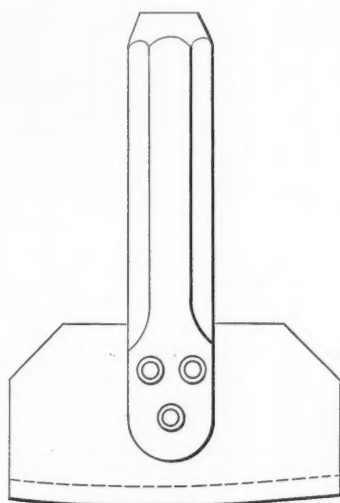


Fig. 4. Type of Tool used to set the finished dummy strips in the gland case

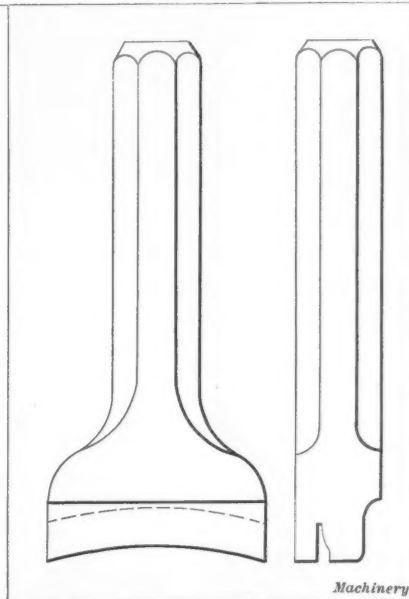


Fig. 5. Type of Tool used to insert the finished gland rings

cases. These coils are cut up into the required pieces, which are forced into the grooves of the spindle and gland cases. Ordinarily about five sections to each ring are set in with a clearance of 0.012 inch between each section, which is to allow for expansion. Having the sections securely calked in both the spindle and cases, they are then machined to the proper diameter and formed, as shown in Fig. 6. The casing that holds the gland strips is detach-

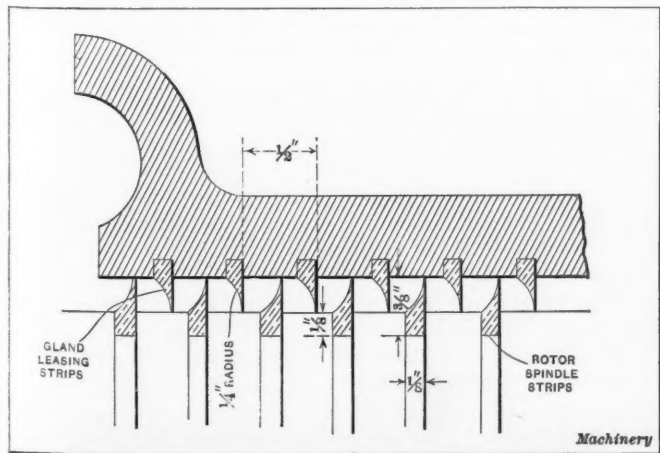


Fig. 6. Spindle of the rotor and the gland strip casing

ameter. Second, with a suitable holder on the lathe faceplate, finish these rings to the correct diameter and form. Third, cut the rings into the required number of pieces (see Figs. 7 and 8); they are then ready for inserting in the spindle and gland cases. For this purpose two tools are made, one machined as shown in Fig. 5 for the spindle rings, and the other machined to fit the gland rings for the cases. Experience has proved that these tools stand up best when made from a soft steel of suitable carbon that will toughen under oil tempering; and with careful manipulation of the tools, a very satisfactory job may be done by this method without sending parts to the shop.

\* \* \*

It has frequently been claimed that the great number of young men graduated yearly from the higher technical institutions in Germany tends to create an over-supply of highly educated men in the industries, and to lower the rate of compensation of the whole engineering profession in that country. During the past year the number of students at the eleven higher German technical institutions was still on the increase. At the institution in Berlin there were close to three thousand students on the lists. At Munich there was about the same number, and at several others about fifteen hundred students. In all, there were about seventeen thousand students at these eleven institutions, an increase of 3.4 per cent over the attendance during the previous year.

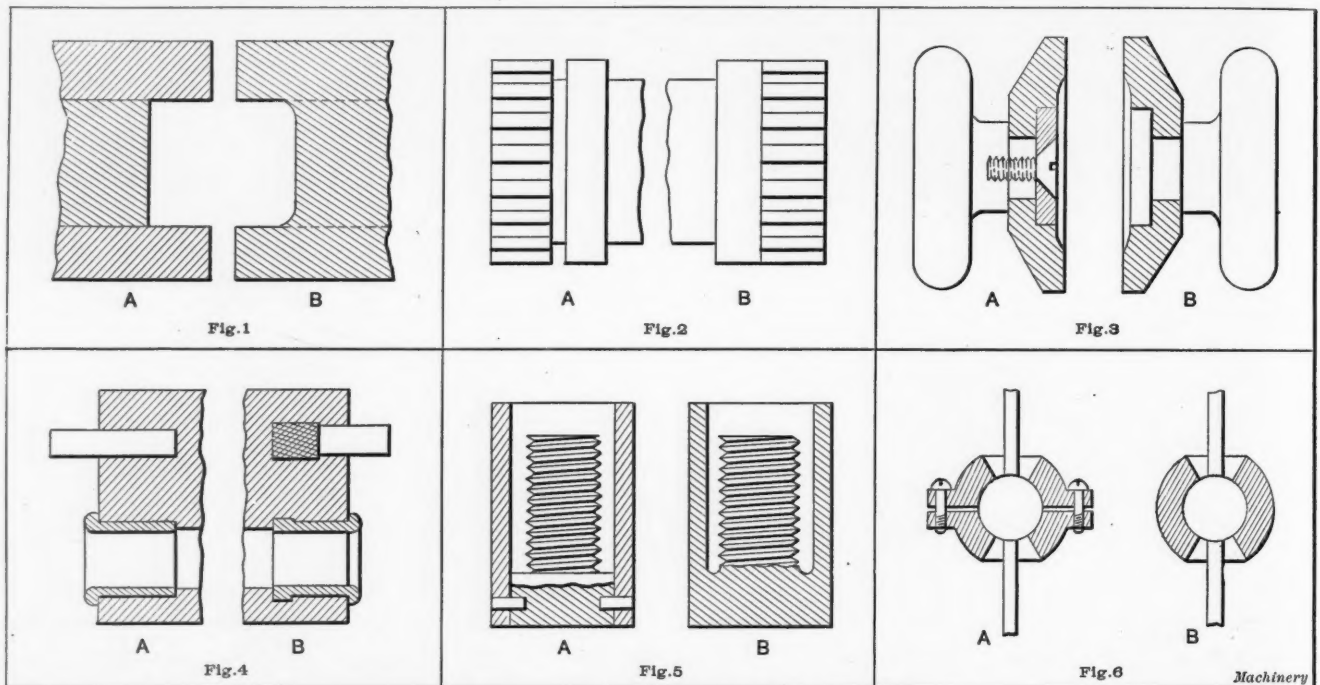
## DEVICES MADE POSSIBLE BY DIE-CASTING\*

### ADVANTAGES OF THE DIE-CASTING PROCESS TO THE DESIGNER

BY CHESTER L. LUCAS†

**D**IE-CASTING has done a great deal for the designer and manufacturer of small metal articles. By a proper knowledge of what may be accomplished by this process, the work of the designer is greatly facilitated, and by taking advantage of the different points in his favor, he may produce a superior product. Some of the advantages of die-casting are diagrammatically shown in Figs. 1 to 6. These views illustrate the results that can be obtained by this process. In these illustrations the ordinary method of securing a desired result is given at the left, while at the right is shown how much better a result is secured by die-casting. Take, for instance, Fig. 1: at A is shown a very ordinary construction, in which two plates are laid over a central block in cases where, because of the difficulty in machining between the plates it is not possible to make the entire piece solid. By die-casting, this piece can be made solid, as shown at B, with fillets in the corners which greatly strengthen and finish it. In Fig. 2 is shown the usual method of cutting gear teeth up to a shoulder. This is invariably provided for by cutting a

ly prevent pulling out. Of course the shrinkage of the die-cast metal helps to hold these inserted parts even more firmly in place. Fig. 5 shows a case in which die-casting can be used to great advantage. The construction shown at A cannot be secured with ordinary machining methods on an integral piece. With one-piece construction it would be impossible to cut the thread on the central stud, as the space between it and the walls would be insufficient to use a die. The only solution would be to make the central threaded section on a separate piece and pin the outer casing over it. At B is shown the result that may be readily obtained by die-casting. It is only necessary to put a core in the die, and after the die-casting has been finished the core may be unscrewed from the casting. Turning now to Fig. 6 we see at A the familiar ball and socket construction in which the halves of the sprocket are necessarily made separate and screwed together about the ball. At B is shown the die-casting method of securing this result by first making the ball and casting the socket around it. By using the proper alloys



Figs. 1 to 6. Design Advantages to be gained by Die-casting

recess into which the gear-cutter may "run out." At B is shown the possibility of die-casting for work of this kind. The dies may be constructed so that the gear teeth run up close to the shoulder, strengthening the teeth and simplifying the construction. In Fig. 3 is shown a knob construction, in which the knob must turn within the plate. This is usually done by making the knob itself of two pieces, as at A, with a flange that is screwed into place after assembling. By die-casting the flange, as at B, and coating the contact surfaces with a graphite paste, the knob may be cast in place and still be freely turned when finished. This is an advantage of die-casting that is being made use of to a very great extent.

In Fig. 4 at A is shown a method of inserting steel pins or bronze bushings in another base metal, the whole dependence for strength being placed on driving fits. At B is shown the method employed for inserting steel pins or bronze bushings in die-castings. As the metal is cast around the insert, the ends of the rods may be knurled and the bushings may be turned with projecting flanges so that the die-casting metal will embed itself thoroughly around the inserts and effective-

for the die-casting metal any desired degree of friction can be secured.

Aside from the construction advantages that die-casting gives, there are often cases where a designed article could not be manufactured at all, except at a prohibitive cost, were it not for die-casting. Two excellent illustrations of this point are in evidence in the two types of "Stoco" instruments shown in Figs. 7 and 11. These are made by the Standard Optical Co. of Geneva, N. Y., and are two of their line of high-grade opticians' instruments. After this company had designed these instruments, it found that it had manufacturing problems that could only be solved by die-casting of the highest order. The H. H. Franklin Mfg. Co. of Syracuse, N. Y., was given the proposition and is now making practically all of the parts for these instruments. When the die-castings reach the Standard Optical Co.'s factory they must be ready for assembling, and as no machining operations are performed save tapping and plating, the work must come from the dies finished in every sense of the word. One of these instruments is shown in Fig. 7. This device is a tilting lens chuck, and is used when boring the holes in spectacle lenses of any curve or thickness. The lens may be tilted in any position or held horizontal without the necessity of a special adjustment for each position.

\* For additional information on die-casting practice see "Van Wagner Mfg. Co.'s Die-casting Practice" 1 and 2, published in the January and February, 1913, numbers of MACHINERY and articles there referred to. See also MACHINERY's Reference Books No. 108 "Die-casting Machines" and No. 109 "Die-casting Dies and Methods."

† Associate Editor of MACHINERY.

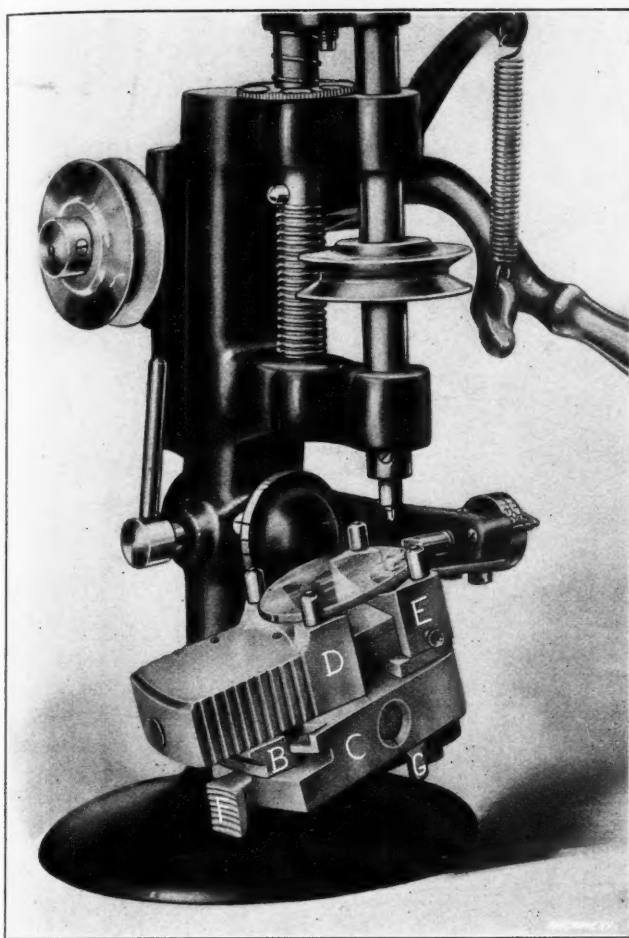


Fig. 7. "Stoco" Lens Chuck in Use

As many lenses require boring at a certain distance, in millimeters, one side or the other from the actual center, this lens chuck may be adjusted by the small lever, using the graduated scale so that the entire chuck may be swung sideways to accomplish this. Lenses are drilled half way from each side, and with this chuck the lens is quickly relocated after the first half of the hole is bored. The chuck may be taken apart for cleaning without any tools whatever.

The lens chuck is also shown assembled at A in Fig. 9, and the succeeding six views show the parts of the device separately. By referring back to Fig. 7, it will be seen how this instrument is used for drilling. To give an idea of the complicated mechanism, it should be noted that jaws D and E may be moved independently of each other for locating the lens longitudinally on the device. The jaws slide on a swiveling sub-base B and these three parts may be swiveled about a central axis by depressing locking bolt F, which, as shown in Fig. 9, has teeth that engage those in sub-base B. There is also a limit stop G for locating the fixture any desired amount off center. These parts, of themselves, comprise good examples of die-casting, because there are under sections, gear teeth and other difficult points of construction to be taken care of. When it is considered that, in addition to their individual difficulties, these pieces must be die-cast

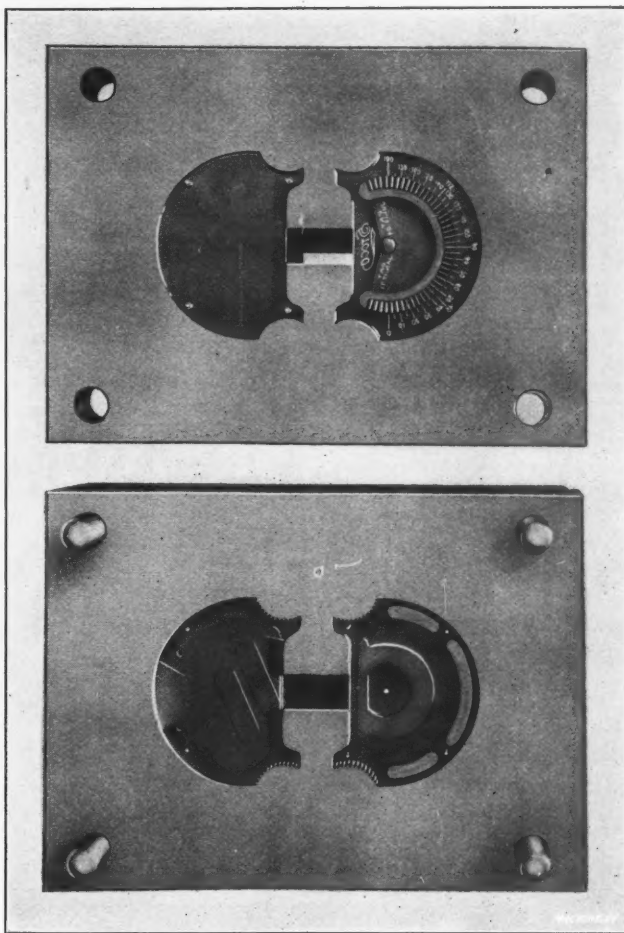


Fig. 8. Die-casting Mold-halves for "Stoco" Inclinometer

so that they will slide together perfectly and work freely without excessive play, it will be realized what possibilities die-casting has.

A description of one of the die-casting molds used on this job should be of interest, and we have selected the mold or die used for casting the base of this device. This base is shown at C, Fig. 9, and the working drawing of the mold is shown in Fig. 10; its construction is as follows: The face-plate A is a plain flat plate that is clamped to the working face of the die-casting machine; upon this plate the mold is built. Resting on the upper side of plate A is plate B. Plate B is an important part of the mold, as it contains the outline of the piece and through it work the three cores C, D and E that form the under cut sections of the piece, and the round beveled edge hole at the front. These may all be observed at C in Fig. 9. Upon plate B is imposed upper die-plate F, in the face of which are the projections necessary to form the recesses and slots in the top of the die-casting. As with other types of die-casting molds, the metal enters the mold cavity through gate G. The supply is cut off and the sprue is severed by sprue-cutter H that works within the gate G. The end slides C and D, as well as the core-pin E, are operated by toggles I, J and K, respectively. The slides and core must, of course, be removed from the casting after each piece has been made. This allows the casting to

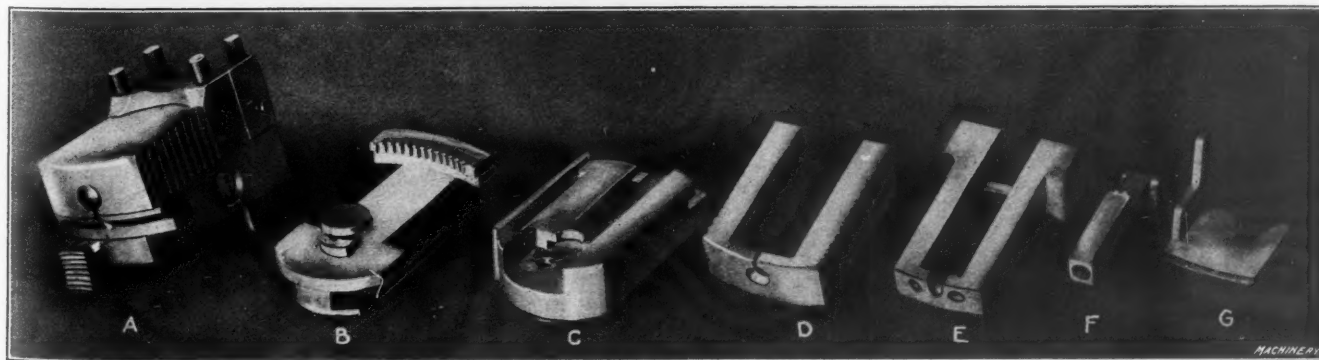


Fig. 9. The Lens Chuck and its Principal Parts

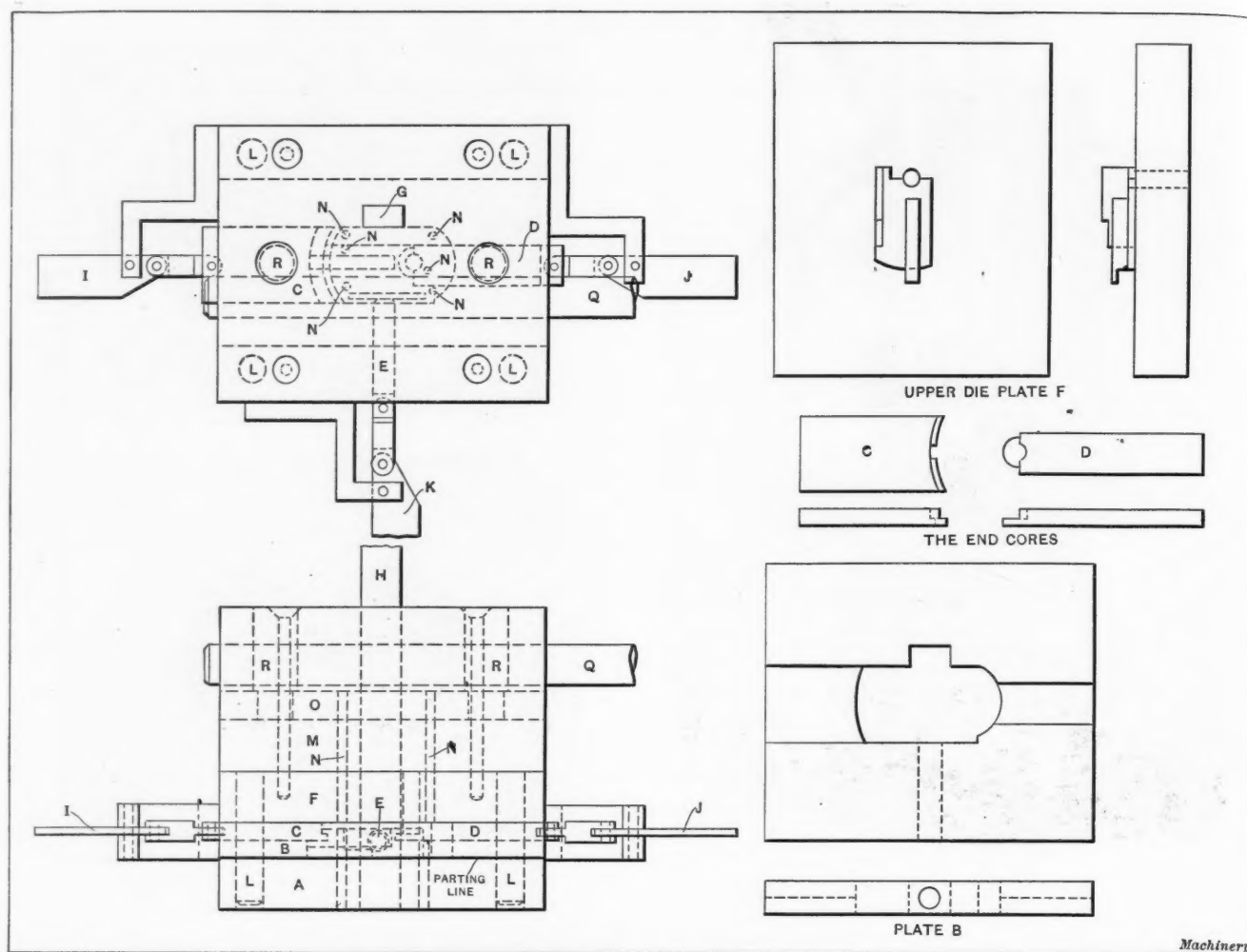


Fig. 10. Die-casting Mold for the Lens Chuck Base shown at C, Fig. 9

be taken from the mold, after which the slides are put back into position for the casting of the next piece. It should be explained that the mold parts between the plates A and B as indicated. Driven through plates A, F and B are the four dowel-pins L that work through holes in plates B and A, insuring perfect alignment of the parts. Plate B is permanently attached to plate F. At the right-hand side of Fig. 10 the principal parts of the mold are shown separately.

The above description refers to the die-casting mold proper, but the mechanism for ejecting the casting from the mold is also interesting. It consists of the ejector box M and ejector pins N, held at their upper ends in ejector plate O. After the casting has chilled, and the mold has been opened at the parting line, the toggles I, J and K are operated and the cores and slides pulled back. Then crank Q is turned, which advances the ejector plate O by means of racks R, meshing

with teeth on the crank, and therefore causes the ejector pins to push the casting from the die cavity.

#### Another Die-cast Instrument

Fig. 11 shows another of the "Stoco" instruments for opticians' use. This is an inclinometer, used for determining the axes of lenses. In use the instrument is held between thumb and finger, and the lens jaws, nominally closed by spring pressure, are opened by pressing the finger lever at the bottom and the lens inserted. By tilting the instrument and lens until the marked axis of the lens coincides with the vertical line, the inclination is readily found. The pendulum is free to find its own location by gravity while the instrument is being inclined, and when the lines coincide the instrument is tilted backward, thus causing the pendulum to find its bearing in the serrated portion of the instrument. By noting a center line on the pendulum in connection with

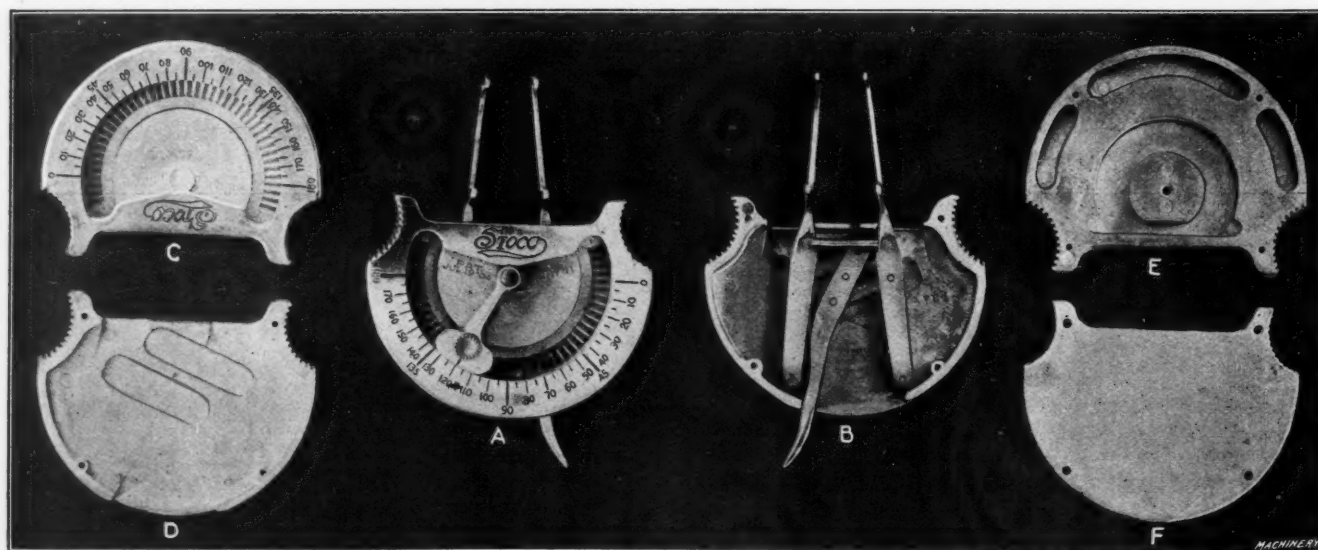


Fig. 11. "Stoco" Inclinometer with Face and Back Views of its Parts

the graduated arc on the body of the instrument, the angle of the lens axis may be observed. Fig. 11 shows at *A* the assembled instrument; at *B* the instrument with the cover removed; at *C* and *D* the outsides of the two main castings; and at *E* and *F* the inner sides of the same pieces. The levers that work inside the instrument, as well as the pendulum, are die-cast, using an alloy that is stiff enough so that in case of injury the levers will break before bending. Should they bend, the accuracy of the instrument would be impaired, while in case of breakage they could be replaced at slight cost.

The illustration Fig. 8 shows the working faces of the die-casting mold used for producing the two halves of the body of the instrument. As will be seen, these two castings are cast in the same die. In one mold-half is the impression of the rear side of each piece, while in the opposite mold-half the front sides are reproduced. The metal enters the mold cavities through the square opening or gate at the center, and after the die cavity has been filled the sprue cutter working in the same opening severs the sprue from the casting and pushes it out of the gate. At each operation of the die two complete pieces are made. The fact that the lettering and figures must be depressed in the finished casting means that they must be raised in the mold cavity. This impression is much more difficult to produce than it would be if the figures and letters were to be made raised on the casting.

These "Stoco" instruments of the H. H. Franklin Mfg. Co. are excellent examples of the possibilities of die-casting, and

## THE DESIGN OF BRONZE BUSHINGS

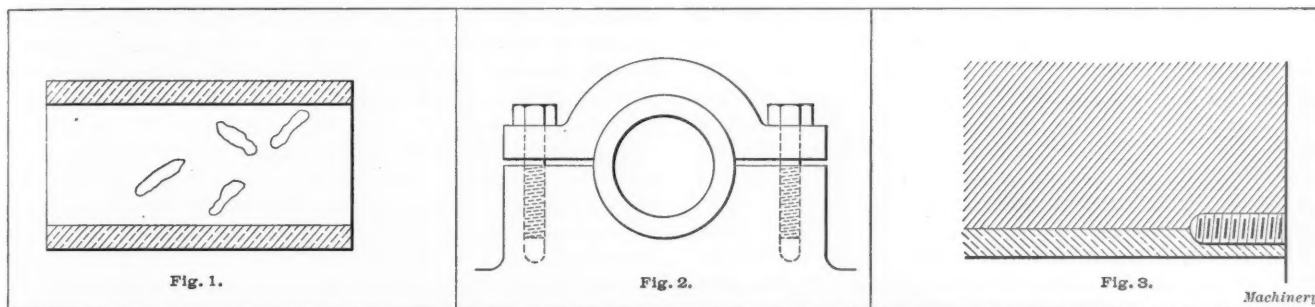
BY B. D. PINKNEY\*

A branch of machine design that I have not seen treated is the proportioning of bronze bushings for shaft bearings. For several years I was engaged in the design of machinery on which large numbers of bronze and phosphor-bronze bushings were used. It was important to get the bushings just thin enough so that their stiffness was not impaired while being forced in place, owing to the high cost of bronze and phosphor-bronze. A bronze bushing of 5 7/16 inches bore by 8 1/2 inches long by 1/4 inch thick was distorted in being forced into a box with sufficient pressure to warrant its being secure. This bushing had the appearance of having been bruised with a hammer, an exaggerated idea of its condition being shown in Fig. 1. The high ridges appeared very soon after the shaft was rotated in the bushed box. A bushing of the same bore and length but 3/8 inch thick was forced in with the same pressure and showed no sign of distortion.

The following rules for forcing bushings into place were formulated from the results of a series of experiments on bushings from 1 to 6 inches bore and of lengths varying from one to six diameters:

*First:* The thickness of the bushing varies approximately as the square root of the product of the bore and the length.

*Second:* The amount that the bushing should be oversize to obtain a substantial force fit varies as the square root of the bore.



Figs. 1 to 3. Bushing damaged while being forced into place and two methods of securing bushings

they should serve as reminders to the designer that die-casting is one of the modern processes at his command, and if properly made use of may prove the solution of some of his manufacturing problems.

\* \* \*

Diesel engines are broadly divided into two classes, namely, the two-stroke and the four-stroke cycle. In both types a cylinder full of air at atmospheric pressure is compressed by the piston at the top center till its pressure becomes about 500 pounds per square inch. The compression raises its temperature to about 1000 degrees F. At this instant a small quantity of oil fuel is blown into the very hot high-pressure air by means of a blast of air at still higher pressure. The oil is broken into a fine spray and its admission lasts only for one-tenth of the downward stroke. During this short time much of the oil is burned in the hot air. The aim is that the compression shall proceed at the critical rate which shall permit the increase of volume occupied due to the motion of the piston and the increase of temperature to be so balanced that the pressure will remain constant until all of the oil has been burned. After this the expansion of the hot gas will still further push the piston down and the pressure will rapidly decrease. The maximum temperatures actually obtained in the cylinders are very high, approximating in some cases nearly 3000 degrees F. It is these exceedingly high temperatures which occasion much of the special difficulties of Diesel engines, and it is necessary to keep the rubbing surface of the metal exposed to the hot gases sufficiently cool to permit of their retaining their lubrication; it is also necessary to prevent all the metal with which the heat comes in contact from becoming so overheated as to impair its strain-resisting properties.—*J. T. Milton, in paper "The Marine Diesel Engine," read before the Institution of Naval Architects, April 2, 1914.*

$$T = 0.05\sqrt{BL} + 0.05 \text{ inch} \quad (1)$$

$$O = 0.0008\sqrt{B} \quad (2)$$

where  $T$  = thickness of bushing in inches;

$B$  = bore of bushing in inches;

$L$  = length of bushing in inches;

$O$  = amount bushing is oversize in inches.

For bushings that are not forced into place, but are held in position by friction clamps in order to facilitate removal, as shown in Fig. 2, or for bushings which are placed in a pocket in a frame and held in place by babbitt, the thickness is obtained from Formula (3), where it will be seen that the length is not a factor:

$$T = 0.125\sqrt{B} \quad (3)$$

It is well to provide means for fastening a bushing in the box to guard against the possibility of rotation—particularly in the case of those of 1 15/16 inch bore and over. The writer uses one or more screws, depending upon the size of the bushing, fastened "half and half" in one end as shown in Fig. 3. The number of screws that are required may be found by means of Formula (4), using the next larger whole number. Thus, if the required number of screws  $N = 1.35$ , use two screws.

$$N = \sqrt{B} \quad (4)$$

I have used these formulas for several years with the best of results and, no doubt, many of MACHINERY's readers will be pleased to get some information along this line.

\* \* \*

An International Congress of Inventors and Industrial Artists will be held in Lyons, France, August 17 to 21, this year. The congress will discuss questions relating to international patents, the exploitation of patents, proper means for encouraging inventors and the cost and duration of patents.

\* Address: 524 E. Third St., Newport, Ky.

## THE USE OF GAGES

BY F. W. GATES\*

A few months ago a body of automobile manufacturers from abroad visited this country to inspect our American manufacturing methods in their industry. While visiting one of our large plants they were given a list of finished parts that make up a complete car, and in passing through the plant they marked, with a specially colored chalk, one piece taken at random from each pile of completed parts. Workmen, following the party, took the marked parts to the assembling department and when the visitors had completed their round, they were escorted to the street in front of the office building and there stood the pieces which they had selected, assembled, mounted, motor running—everything ready to take them for a spin. Any American who is not proud of an achievement like that is a fit subject for—well, some other country.

Anything approaching a feat of this kind would be impossible without the use of gages. Every single part from the tiniest screw to the motor casting had to pass through its particular gage, so when parts reached the assembling floor they "went together" without any filing, grinding, fitting or grumbling. It was so often the case that all the profits made by the rest of the factory lost themselves in the assembling department, that careful gaging is now a practical necessity in almost every factory producing tools or machinery. It is absolute folly to expect interchangeability of parts if different workmen measure different parts in different ways, using different tools made by different manufacturers. A measuring tool may be ever so fine and accurate, it is still a tool and not a gage. The difference is that a tool is an adjustable device for taking the dimension of various articles; while a gage is a standard to which one article must be fitted. A tool will measure a whole range of sizes, having adjustable points of contact. A gage measures its one size or shape only and has fixed points of contact.

But there are occasions when the use of standard gages may, instead of bringing about economy, so add to the production expense as to make them positively objectionable. This is the case where close accuracy is not needed to produce interchangeability. For instance, I once inquired of the superintendent of a small machine shop working on a very ordinary class of work what limits he allowed. "Limits!" he exclaimed in indignant surprise, "we don't use any limits—every piece is brought to dead accuracy." Apparently he had not yet learned that "accuracy" is a variable term. Go into one shop and they figure and think in sixty-fourths of an inch and believe that that is close. Go into another shop and they speak of one-thousandth of an inch as if it were half a mile. Now the superintendent mentioned was trying to make all of that common work absolutely exact. He spent a great deal of time in doing it and thought he was succeeding, but I could find a difference of 0.002 inch on one cylindrical projection. The fact is, anywhere within 0.005 inch would have answered the purpose fully as well, and had he been willing to admit the point and put limit gages on the job instead of standard gages, he would have saved at least 25 per cent of his labor cost.

There is no question but that limit gages enable any shop to produce uniform work that will interchange with perfect satisfaction; but it often requires not only careful planning, but also a thorough practical knowledge of the cutting action of certain tools to lay out a system of limits that will bring the parts together without a "hitch." Take the very excellent A. S. M. E. screw thread system. Opposite No. 24 they give the maximum pitch diameter for a screw as 0.3314 inch and the minimum tap corresponding to this size as 0.3334 inch, allowing a difference for a working fit of 0.002 inch. On paper this looks fairly close, but when you are using commercial taps, as most shops do, you will never find a tap that cuts down to its measured pitch diameter. The sharpening always throws up a fine wire edge along the cutting faces and the tap will cut (on a No. 24 size or thereabouts) from 0.001 inch to 0.003 inch over its size as ascertained with a thread micrometer or pitch diameter gage. Hence, if you

should follow the standard literally, you would find a difference between maximum screw and minimum tap hole of from 0.003 inch to 0.005 inch. Even this would not be so bad in the majority of cases, but the standard further provides a tolerance of 0.002 inch on taps and 0.003 inch on screws. So if you should bring together a *minimum* size screw and a *maximum* tapped hole, the difference between them would be from 0.008 inch to 0.010 inch—too loose for anything but very coarse work. We are very apt to forget that tables of limits, such as that referred to, are generally given to show the widest possible range of tolerance and cannot take account of the cutting action of the tools used, even though they may give dimensions for the tools, as in the A. S. M. E. thread standard. The figures are limits, not ideals.

As to the types of gages in general use, too little attention appears to be given to the question, "Is this type adapted to my uses?" Generally speaking a gage should not be of such a design as to necessitate taking it in the hand. It is far better to have gages which can be placed on a standard or base, or fastened to the bench or machine. If this is not practicable, by all means let there be a projecting handle (perhaps screwed into the body part) and cover the handle with a non-conducting fiber. Then the question of "touch" is an important item. Some men think it is incumbent upon them to force the part between the contact surfaces if it is a physical possibility to do so. Others, with a less vicious disposition, touch very lightly. Both extremes can be avoided if it is made a rule that the weight of the part being gaged determines the "touch." That is to say, with the gage opened upward, lay the piece upon it. If its weight carries it down between the contacts, well and good; if it will not go through, consider the part too large. By carrying out this idea, both cylindrical and screw thread work will improve in uniformity greatly.

The ordinary questions of size and touch, which are comparatively simple in cylindrical work, become complicated when screw threads are reached. Here we have both diameter and lead to contend with, and a changing angle of helix adds to the difficulties. I recently saw a machine operator testing ½ inch U. S. S. screws as they came from the screw machine with a female thread gage. The screws fitted with a good "gage fit." I tried one with a thread micrometer and it measured 0.444 inch, or 0.006 inch too small. The operator explained that he thought the "mike" was out of whack. Taking the screw to a "lead tester," it developed that the die was cutting a long lead—about 0.005 inch over size. Now perhaps an experienced inspector would know that a variation in lead on an undersize screw would compensate for the undersize in diameter and (apparently) equalize the fit; but hardly any machine operator realizes it, or ever stops to puzzle out the reason why. Hence, there are places and conditions where a female thread gage is apt to contribute to defective work rather than to avoid it.

In perhaps the majority of cases where constant testing of a machine product is needed, gages of the fork or crescent type for screw threads are far better than female thread gages. But it must be borne in mind that such gages only test the pitch diameter of the thread. They do not take account of variations in lead any more than a thread micrometer does. But, given a die that cuts close to the normal lead, the fork or crescent gage enables an inexperienced "hand" to test the threads (every one) in a mere fraction of the time required for testing in a female thread gage. The care of gages and frequent comparison with standards (which are used for no other purpose) is given scant attention and yet both are of vital importance. Where a working gage is in more or less constant use every day, better results will ensue if at least two are provided, giving out to the workman a new gage each morning, and keeping the one used the day before in the inspection department for comparison with the standard and adjustment if any is needed, having it ready for use again the next day. The chief inspector should also be provided with setting plugs for every size and gage in use. It would be advisable to have these setting plugs certified by the Bureau of Standards at Washington.

It is really astonishing to find how little attention is paid, in this country, to our fundamental unit of length. A factory

\* Advertising Manager, Wells Bros. Co., Greenfield, Mass.

wants some gages; they are bought from some gage manufacturer and purport to be a certain fraction or decimal of an inch. The factory accepts the gages, takes it for granted that the gage maker is working to the right standard (or else they give it no thought whatever) and proceeds to work up their material to fit those gages. But the whole scheme depends upon how long an inch is. The inch is a legal dimension in the United States, legally established and legally maintained with extreme care, and at great expense, by the Bureau of Standards. I care not how painstakingly a manufacturer preserves his primary standard (so-called), if it does not agree with the Bureau of Standards, he's wrong—just as wrong as the farmer who measures with a bushel basket containing only 2135 cubic inches. And yet, in the face of this undeniable fact, it is unusual to find even a gage manufacturer equipped with certified standards. The day is coming when it will be expected and required of gage manufacturers to supply comparison standards bearing the certification of the Bureau of Standards to their accuracy. The gage maker who realizes this and equips for it now will be strictly in line and find a widening demand for his product. The gage maker who sneers at the legal standard and prides himself on his own carefully maintained dimensions will find

himself left alone with them. The inch is  $\frac{1}{39.37}$  of the inter-

national meter, and that meter is officially maintained at Washington, where, for moderate fees, gages of almost every type can be sent and compared, receiving in return a certificate as to just how much variation there is—carried down to 0.00001 inch if desired. Equipped with certified standards, any chief inspector is in position to adjust the working gages of the shop and keep them in good condition. Without those certified standards, he is at the mercy of every toolsmith and gage maker and will find himself in doubt and perplexity all the time.

The first cost of equipment often deters a manufacturing executive from ordering gages, even after he is convinced that he would get more uniform results by adopting the use of such gages. He has lived along, permitting and expecting his workmen to measure his product with their own tools, and he hates to spend the money. The answer to this attitude comes almost automatically: his competitors will produce so much more uniform work at a lower price that he will soon have no work to measure, and so will have need for neither gages nor workmen. I can point to one shop that used to test their screw machine products by micrometers, both cylindrical and thread work. It was one never-ending squabble between the inspection department and the operators. The lost time and defective work sometimes swallowed all the profit on a job. Limit gages of the fork type were installed. The limits were all carefully worked out in advance, allowance being made for the cutting action of taps, hobs, etc.; as many working gages were ordered as needed and enough more to provide one working set in reserve for unusual cases or accidents. No gage was allowed to remain out of the inspecting department over night. Setting plugs were supplied to the chief inspector, and every gage was tested for wear once a day (if used). The general reputation of that shop for precision work has improved wonderfully in two years. Over 90 per cent of former defective work has been made impossible now, and annoying disputes have ended—a most important factor in the smooth operation of the plant. The inspection cost is less than 25 per cent of its former cost and the whole outfit of gages, standards, etc., has been paid for many times by increased profits. Their precision product today costs less than their mediocre stuff of two years ago. It is all due to gages, planned right, made right, used right, and maintained right.

\* \* \*

As another step in the development of wireless telephony should be noted the fact that messages have been transmitted by wireless telephone between the Nauen wireless station at Berlin, Germany, and Vienna, Austria, a distance of over three hundred miles. Special apparatus of new design was employed and it was possible to hear in Vienna a newspaper article read at Nauen.

## TYPES OF ROTARY MAGNETIC CHUCKS\*

BY O. S. WALKER†

During an experience in the manufacture of magnetic chucks, extending over a dozen or more years, our firm has constructed a wide variety of styles of chucks, especially of the rotary type where much variation in the contour of the magnetic face has been in demand. The object of this article is to illustrate and describe some of the more common forms that we have constructed to meet different conditions. The detachable magnetic face feature, which is a well-known characteristic of the Walker magnetic chucks, has enabled us to easily meet these conditions. The electrical features of these chucks are now so well known that it is only necessary for the purposes of this article to discuss the magnetic faces of the chucks and the arrangement of the magnetizing coils. In all the illustrations referred to, the positive and negative poles are indicated by the letters *P* and *N*, these poles always being separated by a narrow ribbon-like space called the magnetic gap, which is filled with non-magnetic metal.

Referring to Fig. 1, it will be seen that a circular path has been provided for the magnetic gap. This form is not only the simplest, but also the strongest possible to construct, inasmuch as the magnetic gap is the shortest length obtainable, thus concentrating the energy produced by the magnet. This style of chuck face, however, is suited for but an extremely small range of work, and while it may be extended by the construction of additional circular poles separated by similar magnetic gaps, it is impossible to locate the poles close enough together to avoid wide dead spaces for work such as rings, which would not cross over the gap from a positive to a negative pole; hence the chuck would have no holding power whatever. The evolution from the circular style of magnetic gap, therefore, has been in the direction of extending the gap radially in order that it might cover an increased range of diameters and have no circular dead spaces.

To this end the style of chuck shown in Fig. 2 was introduced, in which the magnetic gap takes a zigzag course. The fault of this construction lies in the fact that the outer points of the poles are too widely separated, forming wide areas of dead space between them. To remedy this objection, the style of chuck shown in Fig. 3, which is called the radial pole type, was introduced, this style having the sides of the polar branches approximately radial and dividing the circumferential dead spaces evenly. This style of chuck is found to be well suited for holding disks or rings of a considerable thickness, though it is somewhat unsuited for very thin work or for packing on a load of small parts on account of the outer ends of the poles being still considerably separated. To overcome this objection a six-branch radial pole type, shown in Fig. 4, was introduced, this bringing the outer ends of the poles closer together. The style of chuck face shown in Fig. 5 is a further elaboration of the radial pole type, in this case carried to an extreme in order to hold a multiplicity of small parts (especially small washers) in a circular row. Bringing the pole branches so closely together, however, has reduced the range of the chuck for holding single pieces of small diameter concentrically.

The chuck faces described in the preceding paragraphs all pertain to single coil chucks and in the following are described chuck faces which we have constructed suitable for both single and multiple coil chucks, the latter being generally used for chucks of larger diameters where it is desirable to sub-divide the magnetizing power to more thoroughly distribute it over the chuck face. It will be well at this point to call attention to the fact that excessive multiplication of the magnetizing coils in the chuck is detrimental to the action of the chuck in holding a multiplicity of small pieces, inasmuch as the intensity of the holding force of one of the small magnets of the combination is less than that of a like portion of the magnetic circuit of a large magnet of the single coil chuck. The advantage of the multiple coil

\* For additional information on this subject see "The Inside of the Magnetic Chuck," by H. L. Thompson, published in the April and May, 1914, numbers of MACHINERY.

† Address: O. S. Walker & Co., Worcester, Mass.

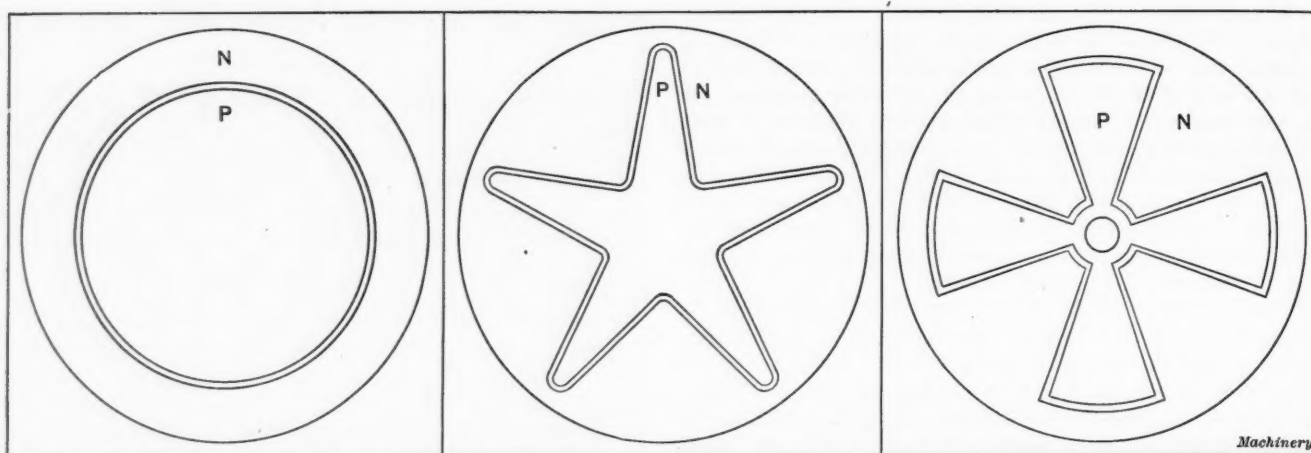


Fig. 1. Chuck with Circular Magnetic Gap

Fig. 2. Chuck with Zig-Zag Magnetic Gap

Fig. 3. Radial Pole Type of Magnetic Chuck

chuck lies in the aggregate power of the whole combination and in the somewhat shortened magnetic circuit.

Users of magnetic chucks, as a rule, desire them for a special purpose, and hence the demand for a wide diversity of styles, each of which has its particular merit. In Fig. 6 is shown a separate segment four-pole magnetic face which can be used either with single or with multiple coils, as previously mentioned. Fig. 7 shows a further elaboration of the separate segment type shown in Fig. 6. In this chuck face, the central portion, as well as the separate segments, is of positive polarity. In Fig. 8 is shown a multi-pole type

similar to the one shown in Fig. 7, except that the central positive pole has been eliminated and in this case the inner ends of the separate positive polar segments have been brought quite near to the center of the chuck to assist in holding single pieces of small diameters. It will be seen from the preceding that still further changes in the style of magnetic faces can be made, but those shown are the ones we have found to be practicable. A very important feature in connection with the design of magnetic chucks should not be lost sight of and that is the feature of concentration of the lines of force to obtain the maximum power. The above

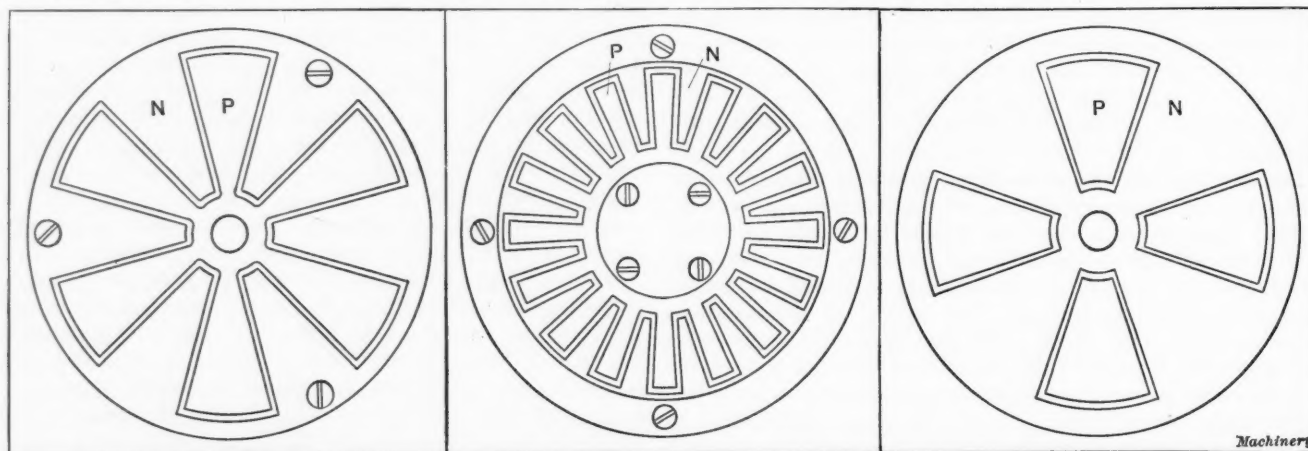


Fig. 4. Six-branch Radial Pole Magnetic Chuck

Fig. 5. Radial Pole Chuck for holding Small Parts

Fig. 6. Separate Segment Four Pole Magnetic Chuck

of magnetic face, in which each of the positive pole segments is bifurcated at its outer and wider ends and into these separations are inserted interlocking radial teeth from the outer part of the chuck face, the magnetic gap, of course, separating the two. This construction is valuable for holding a multiplicity of small parts, as many sub-divisions are formed, with close spacing, so that the whole outer face can be utilized. This chuck face is made in the single or multiple coil styles, depending on the diameter of the chuck.

Another style of chuck face is shown in Fig. 9, this being

holds true for work of considerable thickness, but for thin work the rule is often reversed as, on account of the slight cross-sectional area, only a certain amount of magnetization of the work can be effected, and it is better in such cases to extend the poles and to provide a more diffused magnetic power under the work, even though it be of less intensity.

Whatever may be the shape or extent of the magnetic gap of a chuck, its power as a unit can only be determined by mounting on it a piece of work that completely covers all parts of the magnetic gap.

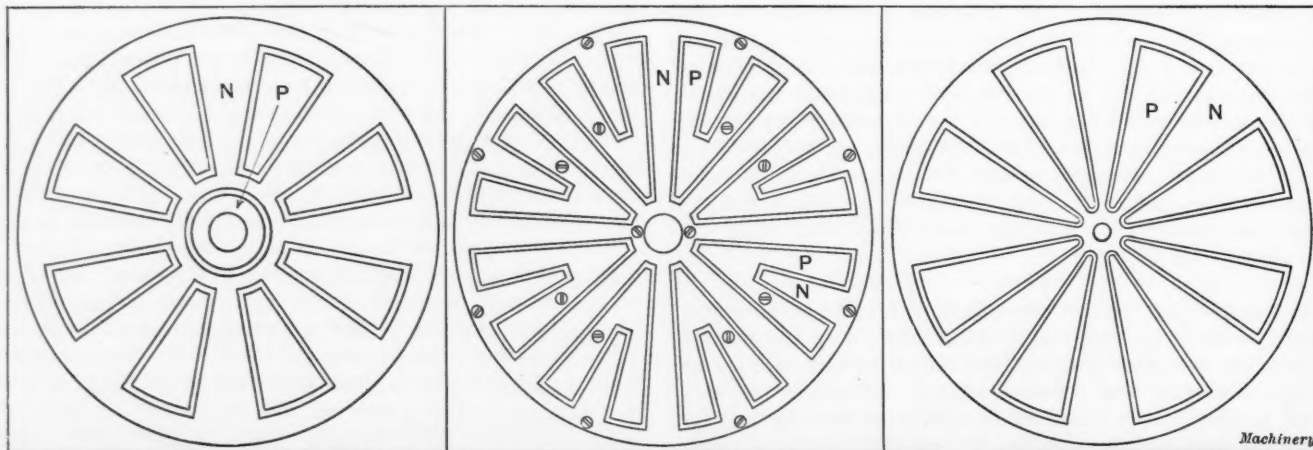


Fig. 7. Separate Segment Chuck with Center of Positive Polarity

Fig. 8. Multi-pole Type of Magnetic Face Chuck

Fig. 9. Separate Segment Chuck without Positive Center

# TABLES OF SPIRAL GEARS HAVING A RATIO OF TWO TO ONE

BY E. S. WIKOFF\*

The accompanying table gives the pitch diameter, outside diameter and center distance for spiral gears having a ratio of 2 to 1, with shafts at an angle of 90 degrees; the angle of the

driving gear is 47 degrees 34½ minutes and the angle of the driven gear is 42 degrees 25½ minutes. These tables will be found convenient by those who have to do with the computing of spiral gears of this class. A great many gas and gasoline engine timing gears are of this special form, and several automobile builders are contemplating using this system. The writer has computed these tables for this special purpose and knows from his own experience with spiral and helical gear-

\* Address: Hagerstown, Ind.

TABLE I. TWO TO ONE SPIRAL GEARS—SHAFTS AT 90-DEGREE ANGLE

Angle of driver D is 47 degrees 34½ minutes; angle of driven gear d is 42 degrees 25½ minutes.  
P. D. = pitch diameter; O. D. = outside diameter; C = center distance.

Gear	Number of Teeth	14 Diametral Pitch			12 Diametral Pitch			10 Diametral Pitch			8 Diametral Pitch		
		P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C
D	6	0.6352	0.7780	0.8982	0.7411	0.9077	1.0479	0.8893	1.0893	1.2575	1.1117	1.8617	1.5718
d	12	1.1611	1.3039		1.3547	1.5213		1.6256	1.8256		2.0320	2.2820	
D	7	0.7411	0.8839	1.0479	0.8646	1.0312	1.2225	1.0376	1.2376	1.4671	1.2970	1.5470	1.8338
d	14	1.3547	1.4975		1.5804	1.7470		1.8965	2.0965		2.3707	2.6207	
D	8	0.8470	0.9898	1.1976	0.9882	1.1548	1.3972	1.1858	1.3858	1.6766	1.4823	1.7323	2.0958
d	16	1.5482	1.6910		1.8062	1.9728		2.1675	2.3675		2.7094	2.9594	
D	9	0.9529	1.0957	1.3473	1.1117	1.2783	1.5718	1.3340	1.5340	1.8862	1.6675	1.9175	2.3578
d	18	1.7417	1.8845		2.0320	2.1986		2.4384	2.6384		3.0481	3.2981	
D	10	1.0587	1.2015	1.4970	1.2352	1.4018	1.7465	1.4823	1.6823	2.0958	1.8528	2.1028	2.6198
d	20	1.9358	2.0781		2.2578	2.4244		2.7094	2.9094		3.3867	3.6367	
D	11	1.1646	1.3074	1.6467	1.3587	1.5253	1.9211	1.6305	1.8305	2.3054	2.0881	2.2881	2.8817
d	22	2.1288	2.2716		2.4836	2.6502		2.9803	3.1803		3.7254	3.9754	
D	12	1.2705	1.4133	1.7964	1.4823	1.6489	2.0958	1.7787	1.9787	2.5150	2.2234	2.4734	3.1437
d	24	2.3223	2.4651		2.7094	2.8760		3.2513	3.4513		4.0641	4.3141	
D	13	1.3764	1.5192	1.9461	1.6058	1.7724	2.2704	1.9269	2.1269	2.7246	2.4087	2.6587	3.4057
d	26	2.5158	2.6586		2.9351	3.1017		3.5222	3.7222		4.4028	4.6528	
D	14	1.4823	1.6251	2.0958	1.7293	1.8959	2.4451	2.0752	2.2752	2.9342	2.5940	2.8440	3.6677
d	28	2.7094	2.8522		3.1609	3.3275		3.7931	3.9931		4.7414	4.9914	
D	15	1.5881	1.7309	2.2455	1.8528	2.0194	2.6197	2.2234	2.4234	3.1438	2.7793	3.0293	3.9297
d	30	2.9029	3.0457		3.3867	3.5533		4.0641	4.2641		5.0801	5.3301	
D	16	1.6940	1.8368	2.3952	1.9764	2.1430	2.7944	2.3716	2.5716	3.3534	2.9646	3.2146	4.1916
d	32	3.0964	3.2392		3.6125	3.7791		4.3350	4.5350		5.4188	5.6688	
D	17	1.7999	1.9427	2.5449	2.0999	2.2665	2.9690	2.5199	2.7199	3.5630	3.1498	3.3998	4.4536
d	34	3.2900	3.4328		3.8383	4.0049		4.6060	4.8060		5.7575	6.0075	
D	18	1.9058	2.0486	2.6946	2.2234	2.3900	3.1437	2.6681	2.8681	3.7725	3.3351	3.5851	4.7156
d	36	3.4835	3.6263		4.0641	4.2307		4.8769	5.0769		6.0962	6.3462	
D	19	2.0117	2.1545	2.8443	2.3469	2.5135	3.3183	2.8163	3.0163	3.9821	3.5204	3.7504	4.9776
d	38	3.6770	3.8198		4.2898	4.4564		5.1478	5.3478		6.4348	6.6848	
D	20	2.1175	2.2603	2.9940	2.4705	2.6371	3.4930	2.9646	3.1646	4.1917	3.7057	3.9557	5.2396
d	40	3.8706	4.0134		4.5156	4.6822		5.4188	5.6188		6.7735	7.0235	

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TABLE II. TWO TO ONE SPIRAL GEARS—SHAFTS AT 90-DEGREE ANGLE

Angle of driver D is 47 degrees 34½ minutes; angle of driven gear d is 42 degrees 25½ minutes.  
P. D. = pitch diameter; O. D. = outside diameter; C = center distance.

Gear	Number of Teeth	7 Diametral Pitch			6 Diametral Pitch			5 Diametral Pitch			4 Diametral Pitch		
		P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C	P. D.	O. D.	C
D	6	1.2705	1.5563	1.7964	1.4823	1.8156	2.0958	1.7787	2.1787	2.5150	2.2234	2.7234	3.1437
d	12	2.3223	2.6081		2.7094	3.0427		3.2513	3.6513		4.0641	4.5641	
D	7	1.4823	1.7681	2.0958	1.7293	2.0626	2.4451	2.0752	2.4752	2.9342	2.5940	3.0940	3.6677
d	14	2.7094	2.9952		3.1609	3.4942		3.7931	4.1931		4.7414	5.2414	
D	8	1.6940	1.9798	2.3952	1.9764	2.3097	2.7944	2.3716	2.7716	3.3533	2.9646	3.4646	4.1917
d	16	3.0964	3.3822		3.6125	3.9458		4.3350	4.7350		5.4188	5.9188	
D	9	1.9058	2.1916	2.6946	2.2234	2.5567	3.1437	2.6681	3.0681	3.7725	3.3351	3.8351	4.7156
d	18	3.4835	3.7693		4.0641	4.3974		4.8769	5.2769		6.0962	6.5962	
D	10	2.1175	2.4033	2.9940	2.4705	2.8038	3.4931	2.9646	3.3646	4.1917	3.7057	4.2057	5.2396
d	20	3.8706	4.1564		4.5157	4.8490		5.4188	5.8188		6.7735	7.2735	
D	11	2.3293	2.6151	3.2935	2.7175	3.0508	3.8424	3.2610	3.6610	4.6109	4.0763	4.5763	5.7636
d	22	4.2576	4.5434		4.9672	5.3005		5.9607	6.3607		7.4508	7.9508	
D	12	2.5410	2.8268	3.5929	2.9646	3.2979	4.1917	3.5575	3.9575	5.0300	4.4469	4.9469	6.2875
d	24	4.6447	4.9305		5.4188	5.7521		6.5026	6.9026		8.1282	8.6282	
D	13	2.7528	3.0386	3.8923	3.2116	3.5449	4.5410	3.8540	4.2540	5.4492	4.8175	5.3175	6.8115
d	26	5.0317	5.3175		5.8704	6.2037		7.0444	7.4444		8.8056	9.3056	
D	14	2.9646	3.2504	4.1917	3.4587	3.7920	4.8903	4.1504	4.5504	5.8684	5.1880	5.6880	7.3355
d	28	5.4188	5.7046		6.3219	6.6552		7.5863	7.9863		9.4829	9.9829	
D	15	3.1763	3.4621	4.4911	3.7057	4.0390	5.2396	4.4469	4.8469	6.2875	5.5586	6.0586	7.8594
d	30	5.8059	6.0917		6.7735	7.1068		8.1282	8.5282		10.1603	10.6603	
D	16	3.3881	3.6739	4.7905	3.9528	4.2861	5.5889	4.7433	5.1433	6.7067	5.9292	6.4292	8.3834
d	32	6.1929	6.4787		7.2251	7.5584		8.6701	9.0701		10.8376	11.3376	
D	17	3.5998	3.8856	5.0899	4.1998	4.5331	5.9382	5.0398	5.4398	7.1259	6.2998	6.7998	8.9074
d	34	6.5800	6.8658		7.6766	8.0099		9.2120	9.6120		11.5150	12.0150	
D	18	3.8116	4.0974	5.3893	4.4469	4.7802	6.2875	5.3363	5.7363	7.5451	6.6703	7.1703	9.4313
d	36	6.9670	7.2528		8.1282	8.4615		9.7539	10.1539		12.1923	12.6923	
D	19	4.0234	4.3092	5.6887	4.6939	5.0272	6.6368	5.6327	6.0327	7.9642	7.0409	7.5409	9.9553
d	38	7.3541	7.6399		8.5798	8.9131		10.2957	10.6957		12.8697	13.3697	
D	20	4.2351	4.5209	5.9881	4.9410	5.2743	6.9862	5.9292	6.3292	8.3834	7.4115	7.9115	10.4793
d	40	7.7412	8.0270		9.0314	9.3647		10.8376	11.2376		13.5470	14.0470	

Machinery

ing, as employed in engine and motor timing gears, that they will prove of real value to the designer. Should a greater number of teeth or a larger pitch be required than given in the tables, multiples may be used.

*Example:*—It is required to find the dimensions for two spiral gears having a ratio of 2 to 1, and provided with 26 and 52 teeth, 6 diametral pitch. Take the pitch diameters for 13 and 26 teeth, as given in the table, and multiply by 2, thus obtaining the pitch diameters for 26 and 52 teeth. Thus:

$$3.2116 \times 2 = 6.4232, \text{ and } 5.8704 \times 2 = 11.7408.$$

To find the outside diameter for 26 and 52 teeth, add twice the addendum to the pitch diameters just found.

Dimensions for diametral pitches not given in the table may likewise be found by proportion. For example, the dimensions for 3 diametral pitch may be found by multiplying the pitch diameters found in the 6-diametral pitch column by 2.

\* \* \*

## TWO INTERESTING PAINTS

BY J. P. S.

As the result of work accomplished by members of the chemical profession, two interesting paints have recently been placed upon the market. The first of these, known as "efkalin," is a light red paint which is applied to any machine members which are likely to run hot and result in damage to the machine. This paint shows immediately if the part is beginning to heat, by a change of color. As previously mentioned, the normal color of the paint is light red, but at a temperature of 50 degrees C. (122 degrees F.) it will become a dark red, and at 70 degrees C. (158 degrees F.) the color changes to a brown-red, while at temperatures exceeding 85 degrees C. (185 degrees F.) the color becomes nearly black. Through the use of this paint, the engineer or foreman is able to tell immediately if any of the bearings are becoming heated, without having to feel them with his hands. An important feature of the paint is that it returns to its normal light red color when the temperature of the part has dropped back to the normal point. Thus the paint will last practically indefinitely, which is an important item because the cost is rather high owing to the expensive ingredients from which it is compounded. "Efkalin" is manufactured by Franz Korn, Halle a/d S., Germany.

"Acalorin" is another interesting paint which has recently been developed by a German chemist. This paint is also used to afford protection against heat but in an entirely different way. Its purpose is to intercept heat rays given off by the sun, thus rendering rooms of a building protected by this paint from 15 to 35 degrees F. cooler than they would otherwise be. It will be obvious that this paint is especially suitable for use on roofs, windows and walls which are exposed to the sun. The paint is a light blue in color and does not have any appreciable effect on the amount of light which enters a room through windows covered with it. This paint is especially suitable for application on glass, slate, corrugated iron and other roofing materials, and also for use on large factory windows. The reduction of temperature in hot weather is the means of increasing the efficiency of employes. The workmen will be more comfortable if the rooms in which they work are not too hot, and as a result their daily output will be more nearly normal than would otherwise be the case in extremely hot weather. The paint may either be applied with a calcimine brush or sprayed onto the roof, walls or windows. The use of this paint may possibly permit the establishment of industries in semi-tropical or tropical countries where it has formerly been out of the question to employ white labor. "Acalorin" is manufactured by Koch & Gruen, Offenbach, A. M., Germany.

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## BENCH LEG PATENTED

The bench leg illustrated with the article "Modern Equipment for Industrial Plants" in the May number of MACHINERY, page 731, engineering edition, is covered in several important features by Patent No. 803,873, owned by the New Britain Machine Co., New Britain, Conn. This notice is published for the benefit of those readers who might infer from reading the article that the design is open to the public.

## TAP FLUTES—FORGED VS. MILLED

BY HARRY E. HARRIS\*

Should tap flutes be forged or milled? That is a question often asked but I do not recall having seen any answer to it in print. In a paragraph in MACHINERY for March, 1914, it was remarked that a maker of taps having forged flutes imitated the shape of milled flutes in order that the purchaser should not be adversely influenced by the fact that the flutes were forged and that, as a matter of fact, forged flute taps should be better than when the flutes are cut from the solid. The time was when high carbon steel ("cast steel") was supplied by the steel mills in such condition that hammer forging and its attendant heats and workings was practically necessary to make the steel uniform, increase its elasticity and refine it generally. This was properly done by several heats of moderate temperature and light blows well distributed and balanced. Whether done by hand or power hammer, it required a conscientious and skillful man. High heats being positively detrimental to high carbon steel, and heavy squashing blows or cold hammering being equally, if not more detrimental, the results of forging were widely divergent and varied directly with the care and skill of the operator, how long he had been standing on his feet, how late he went to bed the night before and various other things.

With the present high state of development of steel manufacture and specialization in different products for different purposes, the high-grade steel company specializing in steel for taps can today produce a material which has passed through heats, forgings, rollings, annealings and drawings that leave little, if any, room for improvement which might be secured by further forging by the tap maker. In fact, the higher the grade and carbon content of the steel, the greater would be the risk to the quality of the tap produced by any such process. The object, then, in forging flutes would be to decrease the cost of manufacturing by getting away from the high cost of milling the material away and the waste of the expensive material itself. To do this the forging must be done quickly with heavy blows and as few heats as possible (this would be a drop-forging operation in one heat) which necessitates a high temperature. High-grade steel with a carbon content great enough to produce taps of proper temper and enduring qualities is very susceptible to overheating and would cause many failures under such treatment. The alternative would be to use a lower grade steel, and in either case the gain to the user would be doubtful when compared with milled taps made from steel of proper analysis and mill treatment. In other words, the ultimate result is better and more uniform if the tap maker selects the best special steel for the purpose (testing it for vital qualities, examining its structure microscopically, and cooperating with the steel mill for improvement wherever possible) and then conserves and enhances its value by careful machining, annealing and scientific heat-treatments, than if he, in order to improve a poorer steel or cheapen his manufacturing costs, changes its form by forging.

The other half of the question is, why should the milled shape of flute be imitated if the flutes are forged? Obviously the milled form should be "imitated," no matter how they are shaped, if a milled flute of proper form is taken as an example. A large proportion of commercial taps have improperly shaped flutes, but more of that later. Forging does not produce the same accuracy as milling. More or less scale and decarbonized surface is present and a keen cutting edge is practically impossible. We forge a lathe or planer tool, but grind both the top rake and the clearance to get a tool having the proper angles to cut efficiently. We would get poor work, if any, and the tool would not last long, if we tried to use it as forged or if we ground but one of the two surfaces that meet at its cutting edge. But we might file or machine the tool to the proper shape, and harden it, and we would then get a tool that would work well and stand up. Then why isn't it much more important to machine the front face of the cutting edges of a tap, where each tooth has so much harder service, than to leave them rough-forged? It is. A test with a tap wrench of a tap of each kind in a

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piece of cast or wrought iron will convince anyone. Try it; or if you can, put the two kinds of taps into service in a tapping machine of some sort, get production speeded up to where it ought to be and see which will give the better threads and last longer. Or you probably know without trying it.

In regard to what milled tap to imitate, one should be taken that has the combination of the greatest strength compatible with the necessary chip room, a shape or profile that in the hardening process will not tend to raise the "heel" higher than the cutting edge (thus causing "back clearance" and making the tap bind) and one which has that part of the flute forming the "rake" of the cutting edge so formed as to easily separate the chip from the metal and break it up into sections small enough to readily work out through the flute and not cause the tap to clog. I have never yet seen a truly correct form of flute described or illustrated in technical journals or books. I have tested many different kinds that have come under my observation, both in laboratory on testing machines and in commercial work under practical conditions, and while they varied greatly in efficiency, the best gave results considerably below those obtained with the ideal form. A tap having a "hooked" or curved front face on the cutting teeth such as that produced by a radius mill, or modifications of the same, produces curling chips which roll up within themselves, forming tight spirals that tend to tear the thread and jam or wedge the tap fast; the deeper the hole and the more tenacious the material the worse this action becomes. On the other hand, a tap with a straight front face to the teeth and with a small corner or radius at the bottom of the flute, will turn off a straight chip which will slide down this front face to the corner at the bottom of the flute. When the end of the chip strikes this obstruction the tendency is to resist further action, compelling metal subsequently removed to wedge into it and over it, and the metal removed will become a compressed lump, clogging and tearing the threads, and generally breaking the tap at an early stage in its use.

The proper form of flute has a front face (or "rake") to the teeth which is flat or straight for a short distance, joining a curve in the bottom of the flute which has sufficient magnitude to bend the straight chip and break it into such lengths as will prevent wedging and allow the pieces to be readily washed out with the lubricant. Greatest effective strength is not indicated by large dimensions from bottom to bottom of the flutes; that is, by shallowest milling. Too shallow milling of the flutes is cheap, making less metal for the tap maker to remove, and thus allowing him to do it at higher speed; but that is the only advantage. It has been found by numerous tests that these heavy taps, while having approximately  $1\frac{1}{2}$  times the torsional strength of properly milled taps, have a varying factor of safety from 0 to 2, while the properly milled tap averages over 9 as a factor of safety. To be plain, and taking  $\frac{1}{2}$ -inch taps to illustrate: In tests on a Riehle testing machine, the heavy taps showed a maximum torsional strength of 1500 inch-pounds, and in threading a test piece they either broke under the strain or else took power of from 750 inch-pounds upward to thread the test piece; the deeper milled taps showing a minimum torsional strength of 1000 inch-pounds (due to their lighter section) averaged but 110 inch-pounds to thread the test piece.

The angle that the front face of the cutting teeth forms with a tangent drawn to the outside diameter circle of the tap is a feature of vital importance in its cutting action and should vary somewhat for different metals. These points are apparently not considered by tap makers generally, commercial taps being largely the same. However, at least one of the more progressive makers has experimented largely on different materials and has produced a standard form that will give excellent results on the most common machine shop materials. This firm also holds itself in readiness to make special taps suited to any peculiar materials or uses, and to give expert, practical advice on the subject. The angle of the back face of the land is also important, in that it is a factor in controlling any distortion of the tap in hardening and also in cleaning out chips in "backing out," although the latter function is not so important where chips are broken up instead of curled or wedged.

The writer has not attempted in this article to give rules, formulas or diagrams for producing properly shaped flutes in taps, as the matter is an exhaustive one and would require a treatise by itself, which would embrace all kinds, diameters and pitches of taps, including special gages, cutters, cutter grinders, flute grinders, etc., that are necessary. In fact, this matter of flutes parallels in importance any other step in the process of tap making, including the selection of steel and heat-treatment. It might even be said to exceed them, as a properly constructed tap of inferior steel might produce good results for a time, but a badly fluted tap of most excellent steel and temper would never be a success. A word about finish. The only excuses for fine polish on the shank of taps, aside from the fact that customers prefer it, is that it rusts less easily; the maker's trademark is stamped on the shank, the quality of the tap can be more readily seen, and the final inspector can see and throw out taps showing any defects such as slight checks or cracks. In regard to the finish of flutes: the flutes, particularly on the smaller taps, should be ground as smooth as possible, as the rougher the surface the coarser the cutting edge, and also the more surface friction resulting from the action of the chips.

\* \* \*

#### PRESENTATION OF THE SEAMAN MEDAL TO GENERAL GORGAS

The Louis Livingston Seaman medal was presented to Surgeon General William C. Gorgas, U. S. A., under the auspices of the American Museum of Safety, Tuesday evening, April 28. The medal was presented to General Gorgas for his work in making the Panama Canal Zone habitable and sanitary for the workers on the canal. The presentation was made in the rooms of the American Society of Mechanical Engineers, New York City, and President Arthur Williams, of the American Museum of Safety, presided. Prof. F. R. Hutton made the presentation speech, and Dr. Norman E. Ditman and Dr. Louis Livingston Seaman recounted the work of General Gorgas as a great sanitarian. In accepting the honor conferred upon him, General Gorgas expressed the thought that the great value of the sanitary work done on the Panama Canal Zone was in showing that the tropics are inhabitable by white men. He predicted that these regions would eventually be great centers of population. Food is produced there with a minimum of effort and the labor of man is rewarded as nowhere else. With the banishment of disease these regions, which are largely uninhabitable now, would become the most important, fruitful and productive sections of the globe. General Gorgas modestly disclaimed credit for the discoveries in sanitation attributed to him. He spoke of his work as that of application of discoveries made by other eminent sanitarians and asked recognition for the four or five hundred young Americans who were his able assistants in the Panama Canal sanitation work and who in the beginning risked their lives and health in promoting the sanitary work.

\* \* \*

#### NEW LIFE-SAVING RAFT

A novel life-saving raft is described in the *Scientific American*. A material known as Java kapok, a fibrous, silky material, the product of a tropical tree found in the East Indies and Java, is said to be very suitable as a filling for mattresses, cushions, etc. The best quality of kapok has wonderfully buoyant properties. The fiber is very fine and will support twenty times its own weight in water, and if enclosed in a leather or artificial leather casing, it will continuously support this weight for two months, before the water finally penetrates the mass sufficiently to make it sink. Ocean liners equipped with mattresses of this kind would be provided with what would virtually be a great number of small sized rafts. An ordinary mattress filled with kapok will easily support a man lying on it. In tests made, it has been found that a mattress covered with ordinary ticking would support a load of two hundred pounds for eight hours. It is stated that the Navy is beginning to use this material for mattress filling, but the merchant marine will not be interested until cushions and mattresses filled with kapok are acceptable instead of cork life-preservers to steamboat inspectors.

## WATCH PENDANT DRILLING AND BOW-BENDING MACHINES\*

AUTOMATIC MACHINES FOR DRILLING, COUNTERBORING AND TAPPING PENDANTS AND FORMING BOWS

BY CHESTER L. LUCAS†

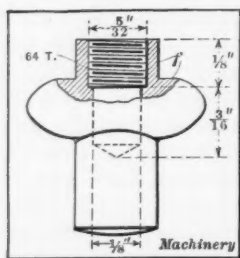


Fig. 1. Operations performed on the Watch Pendant

THE designing and building of automatic machines for making watch parts presents difficulties not found in other lines of automatic machinery construction. In addition to the automatic features to be provided for, the fact that the work is very small and must be handled carefully to avoid abrasion or distortion greatly adds to the designer's problems. In this article will be described two machines which were designed and manufactured by the Sloan & Chace Mfg. Co. of Newark, N. J. The first of these machines is for drilling, counterboring and tapping watch pendants. One of these pendants is shown in section on an enlarged scale in Fig. 1. In Fig. 2 samples of the pendants are shown before machining at A and after machining at B; at C is shown a different style of pendant handled on the same machine. The machine itself is shown in Fig. 4. One of the watch bows is shown before bending at D in Fig. 2 and after bending at E. The machine for bending these bows is shown in Fig. 5 and the details of the machine appear in Fig. 7. Both of these machines are extremely small, being less than two feet long in their greatest dimensions, and either one of them may be picked up bodily without much exertion.

Taking, first, the watch pendant machine and referring to Fig. 1, it will be seen that the work to be accomplished is the drilling of a hole 5/16 inch deep, the counterboring of the outside and the tapping of the larger portion of the hole as marked in the illustration. The blank watch pendants are made by hydraulically pressing a rolled-gold covered composition piece of metal. While the machine is shown as a whole in Fig. 4, it will be best to refer to Fig. 6 in order to understand its design and operation. Referring to the latter illustration, then, it will be seen that the machine is of the multiple spindle type, having three spindles for drilling, counterboring and tapping. The work is held in a turret and revolves to the different spindles. In this illustration, the turret is shown between indexings in order that none of the important parts may be hidden. Power is received at the driving wheel, a part of which is shown at A. At the end of this driving shaft is the miter gear B, that, in connection with the mating gear C carries rotation to the second or counterboring spindle D. Rotation is carried from the counterboring spindle D to the tapping spindle E through

\* For other articles on watch-case making see "Method of Making Watch Case Pendants," October, 1912, and "Watch Case Manufacture" 1 and 2, July and August, 1912.  
† Associate Editor of MACHINERY.

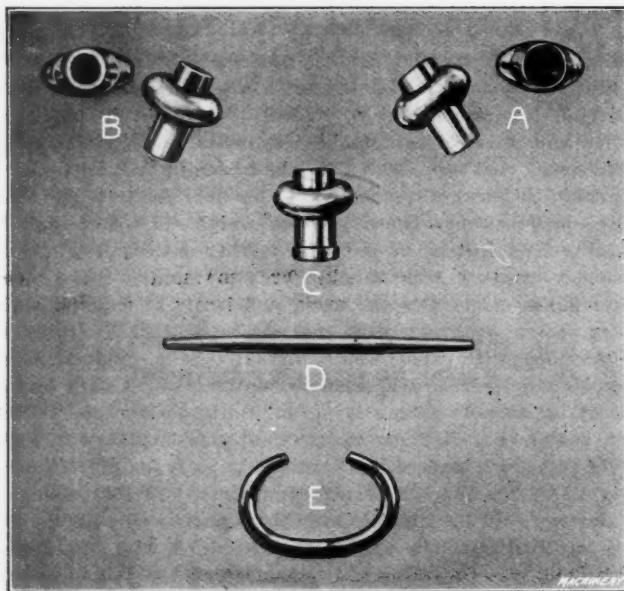


Fig. 2. Samples of Watch Pendants, a Bow Blank and Bow

pinion F on the counterboring spindle that meshes with an idler G, and thence to the gear H on the tapping spindle. The reversing gear for the tapping spindle is also carried from the counterboring spindle by means of pinion I meshing with gear J. Rotation is carried to the drilling spindle K by means of a belt L directly on the tapping spindle.

The watch pendants are held in the four stations in the turret and the turret is rotated by the indexing shaft M. Midway between driving wheel A and miter gear B on the driving shaft is a worm that meshes with a worm-wheel N on the indexing shaft M. At the lower end of the indexing shaft is the segment gear O. The teeth on segment O mesh with those in the turret gear P. By means of the worm and worm-wheel, indexing shaft M is slowly and continuously rotated. As, however, the movement of the turret can only take place when the teeth in the segment are in mesh with gear P, the indexing takes place but once during each revolution of the indexing shaft. During the time that the segment is running idle, the turret is locked in position by a locking bolt that engages one of the four tapered slots cut in the disk Q that is integral with the turret gear P. The locking mechanism

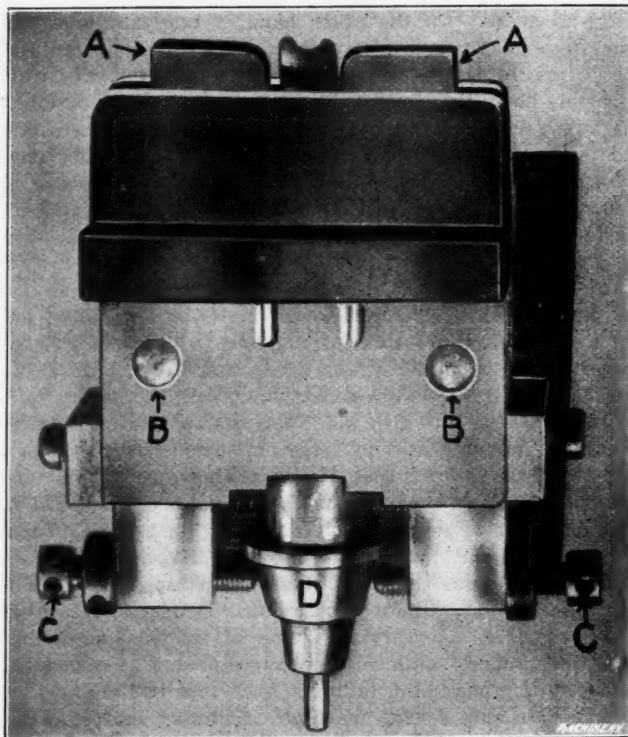


Fig. 3. One of the Turret Chucks

is concealed beneath the indexing segment but its manipulation is very simple, being operated from a cam on the lower part of the indexing shaft.

The turret rotates upon a stud mounted on the base of the machine. Each of the four stations on the turret is provided with a chucking fixture R in which the pendant is held and a chute S that serves to conduct the finished piece away when at the ejection point. One of the chucking fixtures is shown separately on a larger scale in Fig. 3. This type of fixture provides for an automatic chucking of the pendant as well as for the automatic loosening of the jaws from the work and the ejection of the piece. These movements are accomplished by having the two gripping jaws A of the fixture, as shown in Fig. 3, pivoted upon studs B that pass through the body of the fixture. The bottom ends of the jaw levers are fitted with adjustable screws C. The points of these screws project inward and are acted upon by the tapered plunger D. Any upward movement of the taper plunger allows the jaws to open and continued upward movement causes a rod to rise and eject the piece from the jaws. Referring again to Fig. 6, the method of operating the chuck will be seen. The fourth

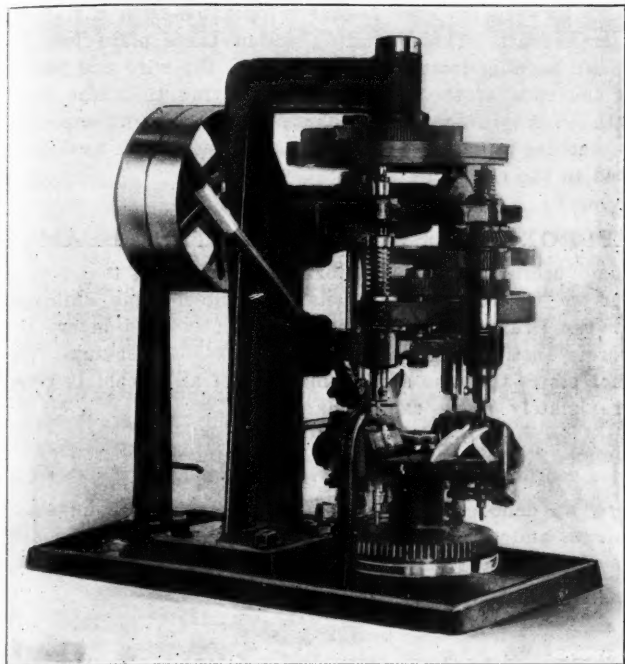


Fig. 4. The Pendant Drilling, Counterboring and Tapping Machine

station of the turret, at the rear, is for the purpose of ejecting the machined pendant and taking on the new blank pendant. At the time of indexing, when the turret is turning and the completed piece is approaching the fourth station, the lower end of the chuck plunger comes into contact with a gradually ascending grooved track *T*. As the piece approaches the ejecting point, the plunger is, of course, rising and allowing the jaws to open; at the same time the plunger raises the pendant in the chuck so that all that is necessary is for it to be swept out of the way. Ejecting lever *U* is operated upon by cam *V*. When the pendant has been raised in the chuck and is ready for ejecting, a sharp drop in cam *V* allows the ejecting lever to be pulled against the pendant by spring pressure, thus knocking it out of the chuck and down chute *S* into a receptacle placed there for the purpose of catching the finished work. The gradual ascent in cam *V* brings the lever back into position for ejecting the next piece that will be finished. The pendants are fed to the machine through a tube *W* which is of the right section to admit the pendant blanks but will not allow them to turn in the tube. At the bottom of tube *W* is the latch *X*. This latch is for the purpose of allowing but one of the pendants to drop from the tube and into the chuck at each loading time. This latch is operated by a cam lever *Y* that is located on the indexing shaft.

The method of feeding the spindles downward for the cutting action is interesting and the three spindles are all operated from the cam plate *Z*. The cam plate is turned by means of spur gearing from the top of the indexing shaft. The ends of the three operating spindles are rounded over and bear against separate cam sections upon the under side of this cam plate. By means of spring pressure the ends of the

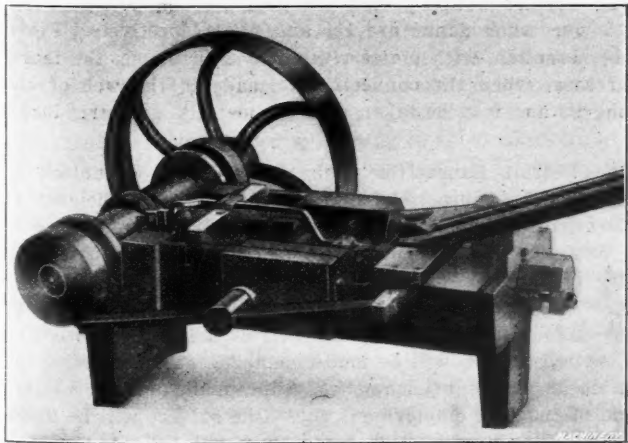


Fig. 5. The Watch Bow Forming Machine

spindles are kept normally in contact with the cam surfaces. As cam *Z* turns, the inclined faces of the cam paths cause the spindles to descend in their brackets, thus advancing the tools in the work. At the end of each cut an abrupt drop in the cam paths allows the tools to jump back out of the work and leave the field clear for indexing. The changing of the tapping spindle direction from forward to reverse is accomplished by means of a friction within the spindle. This friction is operated from the cam plate and when the spindle has reached the limit of the tapping operation, the engagement of the friction clutch causes the reversing gears to act on the spindle and back the tap out of the work.

The operation of the machine is as follows: Loading cam *Y* operates the latch on the feed tube and allows one pendant to drop into the open chuck. Indexing now takes place, the chuck jaws grip the work and it is carried to the drilling station. The drilling takes place while the counterboring and tapping operations are proceeding on other pieces and then the turret indexes, bringing the drilled pendant to the counterboring position. At this point the outside of the pendant is counterbored as shown in Fig. 1 and a subsequent indexing brings it into the tapping position while another pendant blank is chucked and goes to the drilling position. Here a 5/32-inch tap, 64 threads to the inch, taps out the upper

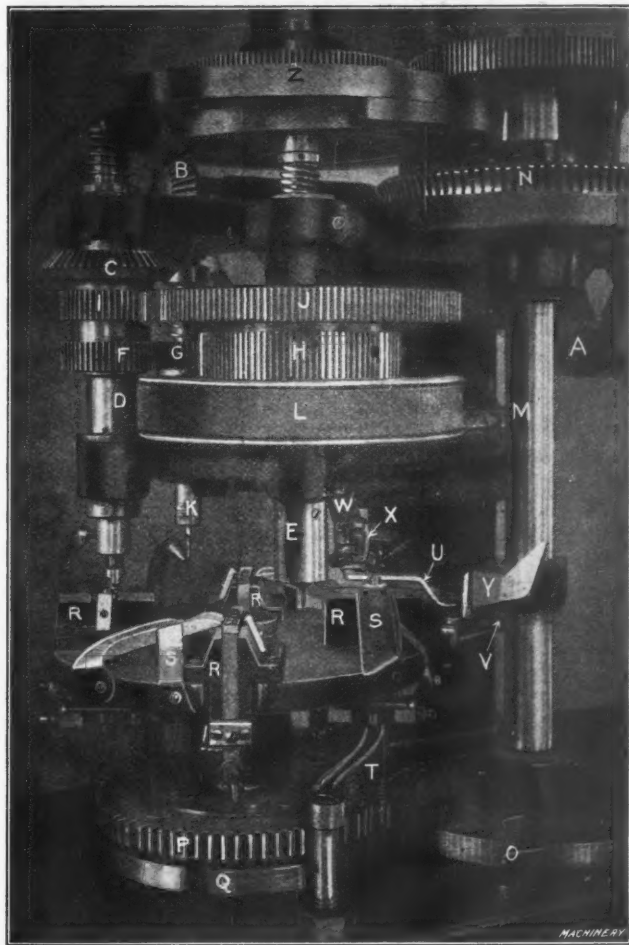


Fig. 6. Details of the Pendant Machine

section of the hole, after which the last indexing brings it into the ejecting position. At this point the ejecting lever comes into action and sweeps the piece from the chuck into the chute and out of the machine. Just after the ejecting operation takes place, the loading cam operates the latch on the tube and allows a new piece to drop into the chuck. Thus one piece is finished at each indexing.

The operation of the machine is entirely automatic after the pendants have been placed in the feed tube. The machine can be used for different types of pendants and, in fact, by proper tooling, for any work requiring similar drilling and tapping operations.

#### A Machine for Bending Watch Bows

In the lower part of Fig. 2 at *D* is shown the blank for a watch bow. This, it will be noticed, is thinned down at the

ends so as to leave the central portion of the link of the correct thickness. The wire stock used is rolled gold and the ends are thinned down by swaging. At *E* in the same illustration is the bent watch bow, and it is for the purpose of performing this bending operation that the machine illustrated in Fig. 5 was designed and built.

The details of this machine may best be seen by referring to the enlarged illustration, Fig. 7. This shows the machine as viewed from above, and those familiar with wire working machinery will recognize that it works on the same principle as the four-slide wire forming machine. The straight blanks for the bows are fed down the inclined chute *A*. Directly under this chute is a semicircular stationary forming tool. This is not shown in the photograph. The principal forming tool or arbor *B* is located on the ram *C* of the machine. This ram has, at its extreme rear end, a roll *D* that is acted upon by contact from a cam *E* on the crankshaft of the machine. The function of this cam is to advance the ram and the forming tool on it. The ram is re-

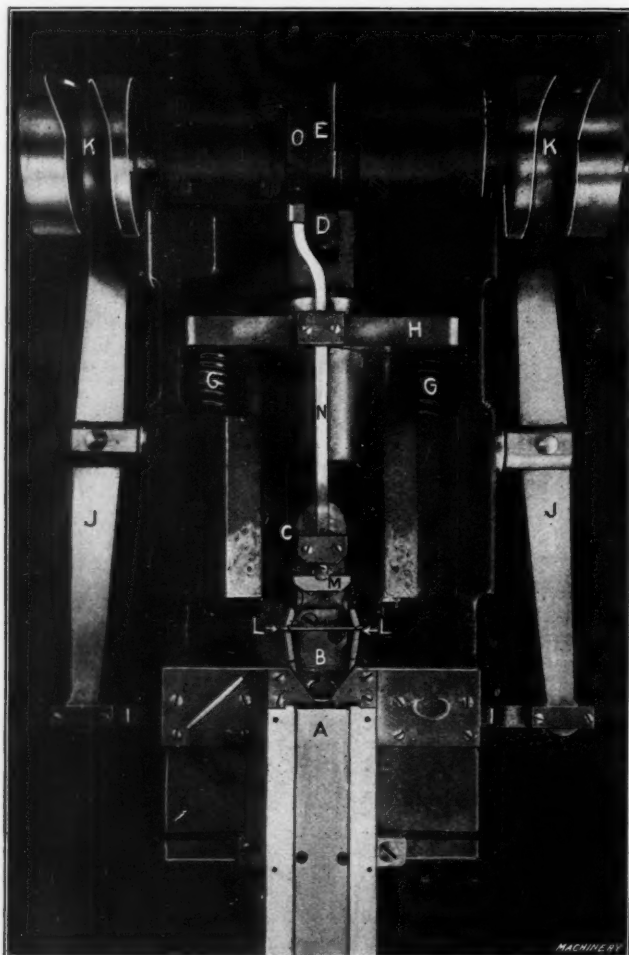


Fig. 7. Plan View of the Watch Bow Machine

turned by springs *G* that bear against a plate *H*, keeping roll *D* always in contact with the cam on the driving shaft. There is a dwell on cam *E* that serves to keep the forming tool *B* and the bow that it has pushed into the semicircular stationary forming tool in its innermost position, while the side arms *I*, actuated by the long operating levers *J*, come in from the sides and force the ends of the wire around forming tool *B*. These levers are operated from cams *K* on the driving shaft. As soon as tool *B* is withdrawn by the spring action of the ram, the formed bow drops from the forming tool *B* to a box beneath the machine. The slight spring of the wire is sufficient to loosen it from the arbor, and as the entire lower half of this arbor tapers sharply, the bow drops off by gravity.

An interesting feature of this machine is the method by means of which the blank is centered in relation to the forming tools. As soon as the blank drops down into the bending position its ends are caught between spring fingers *L*. These spring fingers are evenly brought together when the ram advances, just before the bending takes place, by means of a wedge shaped block *M*. This wedge shaped block is, in turn,

pushed forward by lever *N* that is operated by a cam *O* on the crankshaft. This centering action takes place just before the bending tools start to act upon the wire and insure that the ends of the link are bent, leaving them the same length. Like the watch pendant turning drilling machine, this machine is entirely automatic after the blanks have been placed in the chute.

\* \* \*

#### APPROXIMATE RULES FOR STEEL BEAMS

Some useful approximate formulas are to be found in a paper on "Calculations and Details for Steel-frame Buildings from the Draftsman's Standpoint," recently read before the Concrete Institute (Great Britain) by W. C. Cocking. The author states that the section modulus of an I-beam is given approximately by the expression:

$$M = \frac{W_s d}{10}$$

where  $W_s$  denotes the weight of the section in pounds per foot run, and  $d$  its depth over flanges in inches. The safe load on a 1-foot span for I-sections is approximately

$$\frac{W_s d}{2},$$

the corresponding stress being  $7\frac{1}{2}$  to 8 tons per square inch.

For I-beams used as pillars, the safe load is approximately equal to the safe load per foot run on a span, which measured in feet is equal to twice the width of the flange in inches, the load being taken as applied laterally, and the column considered as fixed at both ends. For a stress of  $7\frac{1}{2}$  tons per square inch the section modulus required is  $M = 0.2 w L^2$ , where  $w$  denotes the load in tons per foot run, and  $L$  the span of the beam in feet. The approximate weight of a beam to carry a given load is:

$$W_b = \frac{W L^2}{1000 d},$$

where  $W_b$  denotes the weight of the beam in tons,  $W$  the total equivalent uniform load in tons per foot run,  $L$  the span in feet, and  $d$  the depth of the beam in inches. The weight of a column is approximately:

$$W_c = \frac{W L}{C},$$

where  $C$  is 2500 for both ends fixed, and 2000 for one hinged and the other fixed. In this case  $W$  denotes the total central load on the column, and  $L$  its laterally unsupported length in feet. The weight of a beam-casing is approximately:

$$W_c = 0.00035 b d L,$$

where  $W_c$  = total weight of the casing in tons,  $b$  the breadth, and  $d$  the depth, both in inches, while  $L$  is the length in feet. The same formula applies to columns. For calculating the effect of eccentric loads on columns, Mr. Cocking recommends the following factors: For I-sections the equivalent central load

=  $1\frac{1}{2}$  times eccentric load if latter is connected to the web of the I-beam,

=  $2\frac{1}{2}$  times eccentric load if the connection is to a flange.

The corresponding factors for an I-beam column with plates over each flange are  $1\frac{1}{4}$  and  $2\frac{1}{2}$ , respectively. For a double I-section, with plates riveted to each flange, the factor is greatest when the connection is made to the web of one of the I's and may be taken as  $2\frac{3}{4}$  times the eccentric load.

\* \* \*

The Detroit Executives Club was recently organized in Detroit for the purpose of determining how the efficiency of local organizations can be increased. E. St. Elmo Lewis of the Burroughs Adding Machine Co., Detroit, is the chief promoter of the idea. The club is at present in a formative stage. Primarily it will be composed of fifty members of as many different organizations in Detroit, and only those who are invited to join will be made members. The object of the club is to study efficiency, scientific management, welfare work, methods of employment, etc. One subject will be taken at a time, and exhaustive researches will be made in factories all over the country.

## A GAGE LIMIT SYSTEM FOR GENERAL WORK

BY FRED W. MCARDLE\*

The system of gage limits here described was devised for use in an engineering office which specializes on general machine design. The various machines designed are built in different factories, depending on the client for whom the work is done, and often without supervision by the engineer; so it is evident that any system of limits used must be simple and readily understood. When a new machine is designed it is almost impossible to make a set of drawings so complete in detail as not to require more or less explanation, and one of the most important items is that of fits. It is not sufficient to give nominal sizes on a detail, as it then leaves the matter to the judgment of the individual machinist as to whether a stud, shaft or other part shall be up to size, over or under. If the man is a careful workman, he either refers it to his foreman, who as likely as not knows little more than

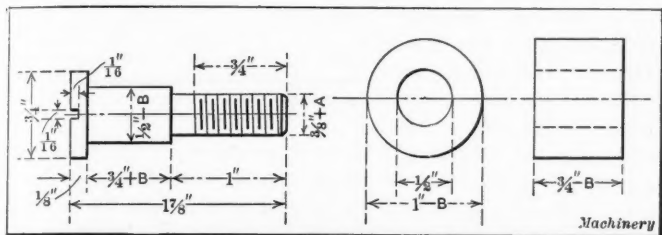


Fig. 1. Examples of Details showing Use of Gage Limit System

### GAGE LIMITS.

All holes are standard reamer size unless noted.  
 +A indicates from plug size to .001 over, -A same under,  
 +B indicates from .001 to .002 over size, -B same under,  
 +C indicates from .003 to .005 over size, -C same under,  
 Finish dimensions unmarked, from .005 under to .005 over.

Machinery

Fig. 2. Form of Gage Limit System for General Work

he does about the matter, or he makes it "full" to allow for final fitting.

In either case there is a loss of time and added expense. This is equally true if parts are designated as "running" or "driving" fits, for still the machinist must use his judgment, which is apt to be such as to leave him on the safe side. If instead of following this practice, the sizes are given in thousandths, with or without limits of variation, it often occurs that the work will be built in a small factory unaccustomed to such specifications, and the cost will be increased by the extra care that is taken with parts that do not require particularly close work, solely because the job bears the hall mark of accuracy on some of the parts. The latter method has the additional disadvantage of causing extra work in placing the limit sizes on the drawing. This, of itself, is something of an item on any design requiring a considerable number of details.

Experience with these and kindred difficulties led to a tentative method that has been developed into a system, in no sense perfect, but one which can be readily used in general work, and which insures good work without fitting or questions as to fits; these are decided by the designer and indicated in a way that is easily understood by the workman. This result is accomplished by affixing to all dimensions which require limiting, a plus or minus sign and a letter, A, B, or C, which indicates the amount of variation; plus indicating over nominal size and minus indicating under size. A rubber stamp giving the data presented in Fig. 2 is used on each detail sheet and the various details are marked accordingly, with the result that the machinist makes a part regardless of fits, and each individual part is made without the disturbing element of thousandths on some other part.

The gist of the method is this: If a dimension has a plus letter after it, it must be up to size or over, within the limits called for by the letter. Similarly, if a dimension is

followed by a minus sign, it cannot be over size and may be under, according to the letter. A finish dimension without plus or minus letter indicates that the size is nominal, and ordinarily careful work is all that is required. Slots and depressions that would be measured by a plug gage may be considered as holes, and come under the heading "all holes are standard reamer size unless noted." Working on this basis, studs, shafts, slides, etc., are marked minus if a running fit, plus if a driving or press fit, and the limiting letter according to the judgment of the designer. Both the plus A and the minus A dimension may ordinarily be considered as plug size, with this difference—that the plus sign would be used where it was essential that the part be absolutely rigid, as in the neck of a stud where it fastens or is screwed in to another part, making it integral; the minus sign would be used where a part is subject to frequent removal, as in a stop plug or other part where ease in removing is essential. If preferred, however, plug sizes may be specified in thousandths, which of course would admit of no variation. Drilled holes are so marked, and cored holes should be specified. Fig. 1 will illustrate the application of this method to detail work. The roll shown is a running fit on the stud, and it is evident that the two details may be made independently and yet work together without subsequent fitting. It will be noticed that limits are given, both on the length of the shoulder on the stud, and on the width of the roll, and this apparently departs from the general method described. It seems advisable, however, to allow variation when possible, rather than absolute sizes, and in such cases as this, side clearance may be split up between the two details with satisfactory results.

Since the adoption of this method, two machines radically different in class have been designed, and the form shown in Fig. 2 could not be used without modification. One of these machines was of a character that forbade a maximum variation of more than 0.002 inch; the other was of an exactly opposite character, being used on heavy work, subjected to the action of water, and lubricated with heavy grease. In the latter machine a maximum variation of 0.015 inch or even more was allowable, without affecting the action. To meet these conditions, the same rubber stamp was used and the values of the limiting letters changed, as shown in Fig. 3.

After a year or more, it has been found that little or no explanation is required when a drawing marked as described

### GAGE LIMITS.

All holes are standard reamer size unless noted.  
 +A indicates from plug size to .0005 over, -A same under,  
 +B indicates from .0005 to .001 over size, -B same under,  
 +C indicates from .001 to .002 over size, -C same under,  
 Finish dimensions unmarked, from .003 under to .003 over.

### GAGE LIMITS.

All holes are standard reamer size unless noted.  
 +A indicates from plug size to .005 over, -A same under,  
 +B indicates from .005 to .010 over size, -B same under,  
 +C indicates from .010 to .015 over size, -C same under,  
 Finish dimensions unmarked, from .015 under to .015 over.

Machinery

Fig. 3. Special Forms of Gage Limit System for Fine and Rough Work

is put into the shop; moreover, the men seem to take kindly to it. In estimating costs, it is found valuable as an aid to the contractor in getting a closer figure than would be obtainable where nicety of finish would be a matter of guess work. Finally, one additional safeguard is given both to the designer and to the machinist. Errors are almost certain to occur either in the shop or drafting-room, or in both. The writer has a case in mind where cumulative errors in finish, any one or two of which would have had no effect, resulted in apparent discrepancy which affected to a considerable extent the working of the parts. In going over the work it was found that fits were made according to the judgment of

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the man making the piece; in making fits he kept on the side of safety, and no blame could be attached to him for his work. In several parts all fitting on the safe side the net result was over size. Apparently it was a mistake of the draftsman, until the drawings were shown to check up correctly. The only thing that could be done was to alter the parts affected in order to make the machine operative, and there remained a lurking impression in the minds of both the builder and the man who paid the bills that somehow it was the fault of the draftsman, but that he had got out of it on a Scotch verdict, "not proven." The method described may be improved and amplified, but the results obtained from the present form are such that it has been thought inadvisable to introduce additional complication.

\* \* \*

### PROFIT-SHARING AND CO-PARTNERSHIP

An interesting report on profit-sharing and labor co-partnerships has been issued by the British Labor Department of the Board of Trade and is reviewed in a recent number of the *Mechanical Engineer*. This report indicates that under present industrial conditions, co-partnerships and profit-sharing are successful only in exceptional instances. It shows that, as far as the engineering and allied industries are concerned, the present outlook is discouraging. Out of six mining and quarrying companies that started on a profit-sharing basis, the co-partnership scheme has been abandoned. In the metal trades, out of nine firms that started profit-sharing arrangements only one still employs the method, and out of twenty-one engineering and shipbuilding firms, only four still maintain the system. The only trade or industries in which schemes of this kind seem to be successful are those in which the company has more or less of a monopoly and in which the profits are almost assured from the beginning. As an example of this may be mentioned gas works, where out of thirty-four cases reported, in only one instance has the profit-sharing been abandoned. France is the country in which methods of this kind have been longest in existence; in fact, its oldest profit-sharing undertaking dates from 1820. In Germany, profit-sharing has made little progress and many of the arrangements introduced have been comparatively short-lived. Thus, out of fifty-four profit-sharing instances recorded in 1878, only nine were in existence in 1901. At the present time, there are only thirty profit-sharing institutions known to be in existence in that country; twenty-one of these undertakings for which particulars are available employ about 15,000 people. In the United States there are about twenty-five or thirty firms that have introduced profit-sharing schemes, and some of those that have done so are very large. A general survey would therefore indicate that at the present time there is little hope of relieving industries from labor difficulties by arrangements of this kind. A much better method would seem to be the Canadian provision for public investigation and publication of all the facts when differences arise between employers and employees.

\* \* \*

Every new movement is attended by quackery, and no matter how meritorious it may be, the effect of the fakers engaged in promoting it for large personal gains is to discourage and retard its legitimate development. Scientific management of manufacturing plants is no exception. In fact, it has suffered severely from the absurd methods and claims made by "efficiency engineers" who have exploited it to their own profit and the loss of concerns who have engaged their services. The possibilities of scientific management properly worked out are almost unlimited, but they will be realized in the greatest measure when it is developed by practical men who are able personally to do the work they aim to direct. The result of malpractice in efficiency betterment is reflected in the fact that some concerns actively engaged in the study of production methods will not admit that such work is being done for fear of being discredited in the eyes of their workmen. The study is carried on unobtrusively by men who do not pose as "efficiency experts." No radical changes are made, but when the weak places are found changes of method are made gradually.

## REDUCING LABOR COSTS BY BROACHING\*

BY A. B. CORMIER†

The rough forging for a bearing ring and one of the finished rings are illustrated in Fig. 1. In machining these forgings, a prominent automobile parts manufacturer has reduced the labor cost materially by the application of broaching in machining the inside surfaces and the four holes through the ring. In this article a description will first be given of the methods now employed in machining these forgings, after which a comparison will be drawn between the present method and that formerly employed, with the object of showing how the saving of time was made possible by the change.

The rough forgings are made from 0.25 to 0.30 per cent carbon open-hearth steel. The first operation consists of machining the surfaces A which come in contact with the fixture used in broaching the

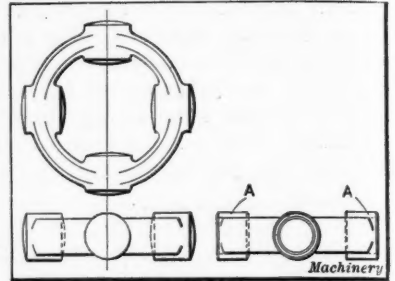


Fig. 1. One of the Rough Forgings and a Finished Ring

inside of the ring in the second operation. The broaching fixture consists of a faceplate which holds the hardened steel block B. This block guides the broach, and the finished surfaces A on the forging are also held in contact with the block to locate the work properly. A set of three broaches is used; the first broach takes a coarse chip because the cut is relatively narrow; the second broach takes a finer chip; and the third broach, which has the maximum width of cut to deal with, removes but 0.001 inch of metal. The last seven teeth of this broach are straight while only the last three teeth of the first two broaches are straight. Accuracy in this operation is particularly important because it is not only employed to finish the forging, but the four surfaces finished by broaching are used in locating the work for all subsequent operations.

The duplex milling fixture on which the third operation is performed is illustrated in Fig. 3. The forgings are

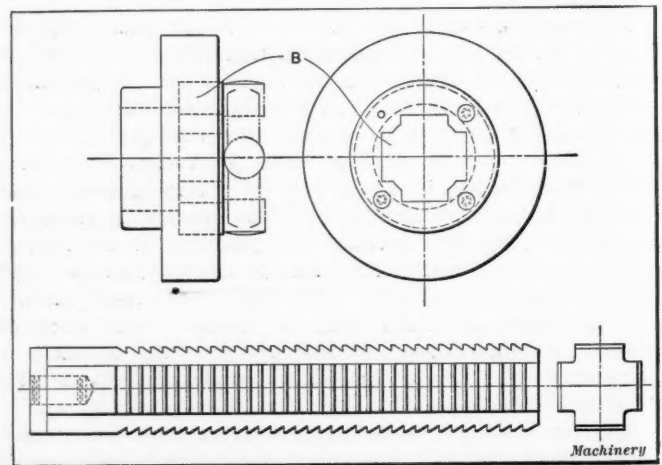


Fig. 2. Broaching Fixture and One of the Broaches used for finishing the Inside of the Forgings

located on hardened plugs C and clamped down against the surfaces A which were machined in the first operation. The two work-holding plugs of this fixture are indexed simultaneously by means of spur gears D, and the blocks are located in position by means of tapered plungers E controlled by operating screws. The milling cutters are employed to finish the outside faces of the forging corresponding to the

\* For additional information on broaching previously published in MACHINERY, see "Broaching a Dovetail Key-seat in a Taper Hole," February, 1909; "Broaching Automobile Parts," April, 1909; "Broaching a Connecting-rod End," June, 1912; "Broaching the Square Holes in Vise Bodies," February, 1913; "Broaching Automobile Parts," June, 1913; "Broaching vs. Milling," June, 1913; "Broaching Pivot Holes in Scale Parts," July, 1913; "Broaching a Vacuum Cleaner Part," July, 1913; "Broaching a Long Keyway," August, 1913; "Points on Broach Making," October, 1913; "Drilling Machine Fixture for Broaching Push-rod Guide Holes," December, 1913; "Broaching vs. Reaming," by F. J. Lapointe, February, 1914; "Broaching vs. Reaming," February, 1914; and "Broaching Round Holes," March, 1914.

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four inside faces which were finished by broaching in the second operation.

After completing the milling operation, the forgings are taken to a four-spindle semi-automatic horizontal drilling machine of special design where four  $31/32$ -inch holes are drilled in each piece. The work is held on a hardened plug *F* of the fixture shown in Fig. 4. The plug has holes in it to admit the drills when they pass through the work. After the holes have been drilled on this machine, the forgings are transferred to another broaching machine where the four holes are broached to 0.999 inch in diameter. In performing this operation, the work is held on a hardened plug *G* of the fixture shown in Fig. 5. This plug also has holes in it to allow the broach to pass through in finishing the holes on opposite sides of the forging. Nothing in the way of an indexing mechanism is attempted on this fixture, the work being lifted off the plug and replaced in position for broaching the other two holes.

After the broaching has been completed, the forgings are burred by the tool shown in Fig. 6. The lower burring cutter

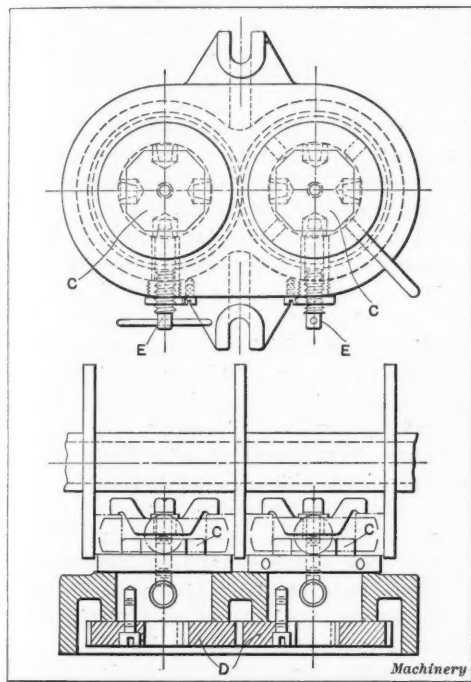


Fig. 3. Duplex Fixture for use in milling the Outside Faces of the Forgings

of the operations except those of milling the outside of the forgings and drilling the holes, these two operations being performed by one man.

The original method of machining these pieces was to first drill and ream the holes on a four-spindle drill press provided with two drills and two reamers. Four box jigs were used in a row on this machine. The second operation consisted of profiling the inside of the forging, a fixture being used for this purpose which had four locating pins. In the third operation, the square hole was broached to the required size, the work being located by a fixture with four pins as in the preceding case. The fourth operation consisted of rough- and finish-milling the outside faces of the forgings on a hand miller, which milled one face at a time.

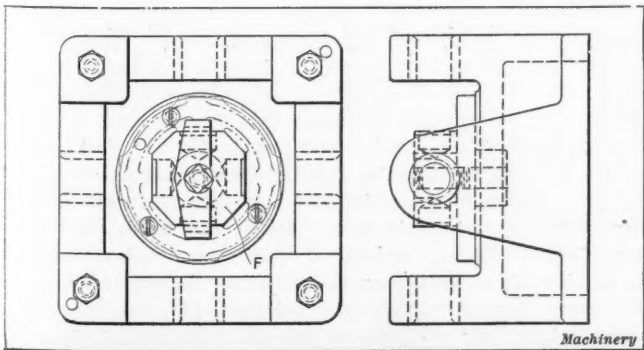


Fig. 4. Jig used for drilling the Four Holes in the Forgings

In the fifth operation the holes were broached to the required diameter of 0.999 inch, and after this had been done the final operation was performed, which consisted of burring the holes by hand.

A great saving of time has been effected by adopting the new method. Through the use of special four-spindle semi-

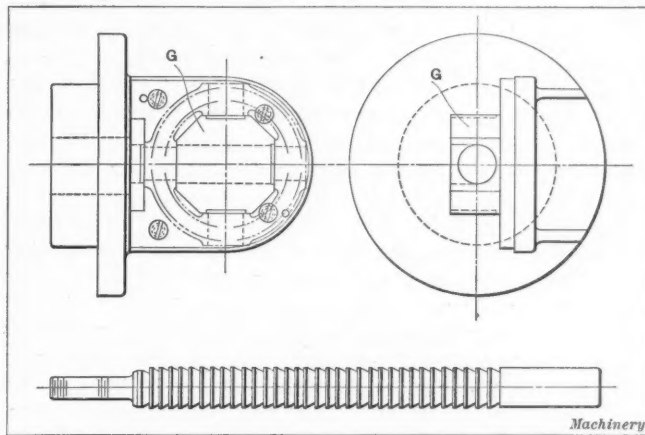


Fig. 5. Broach and Fixture used for broaching the Four Holes in the Forgings

automatic drilling machines, one man is able to finish eight holes in the time formerly required to drill and ream two holes. The substitution of broaching for profiling in finishing the inside of the forgings has not only effected a saving of time, but it requires less manual labor and produces more satisfactory work. There was a tendency to chatter in finishing the inside of the forgings on the profiler. The new milling operation has also been the means of effecting a great saving of time. We were at first under the impression that the length of cut was too short to allow the work to be handled efficiently with power feed, but it was found that when hand feed was used the operator pushed the work across the cutter at a greater speed than was necessary, the result being poorly finished work. As previously mentioned, only one roughing cut is now taken which gives a very nice finish.

In order to obtain the most efficient results, particular attention has been paid to the grouping of the machines in order to allow the work to be transferred from one machine to the other as rapidly as possible. The arrangement is such that when the work is finished on one machine it is laid down within easy reach of the operator of the next machine and so on until the last operation has been performed. This method of grouping is, of course, only possible in factories which specialize on standard products.

It is interesting to note that in the battleship machinery of today there is not found the great amount of copper, brass and gun-metal that was common in ships built twenty years ago. In the propelling machinery of the modern battleship, the weight of non-ferrous metals today equals about 17 per cent of the steel and iron, whereas twenty years ago the non-ferrous metals in the propelling machinery amounted to about 34 per cent of the weight of the steel and iron parts. Except for the very smallest pipes, for example, copper steam pipes are not used in the most modern types of battleships. Gun-metal ends for condensers have also disappeared and the condenser shell is made from sheet steel, which is lighter, although not so durable as gun-metal. It has, however, sufficient life as compared with the probable life of the battleship. In the whole structure of the vessel, however, the proportionate amount of the non-ferrous metals has not been reduced as compared with twenty years ago, on account of the increase in gun turrets, fire control appliances, electric lighting, telephones, etc., where non-ferrous metals are advantageous or necessary.

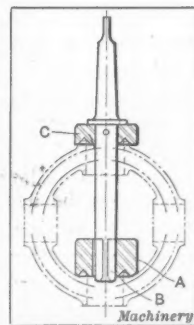


Fig. 6. Tool used for the Burring Operation

## ON INDUCING OURSELVES AND OUR MEN TO EARN MORE MONEY\*

SOME POINTS ON SECURING EFFICIENCY THROUGH COOPERATION OF EMPLOYER AND EMPLOYEE

BY J. C. SPENCE†

THE record of the recent past and the evidence as to the immediate future point to the fact that if the American machine tool industry is to compete for the best workmen, there must be a change in our methods. Competition with Europe and within the trade precludes the possibility of any great increase in the selling prices of our products. The changes, then, must take place within our organization; we must get more salable goods per dollar of investment, and this result must be attained, not by a decrease in the earnings of all concerned, but by an increase, else we will gradually lose the best of our men to such other industries as have, at present, a larger margin of profit. This movement has already made inroads into the field of good machinists, and everyone is familiar with the statement that "we can't get the kind of man that we could some years ago." This lack of good men is, of course, not due entirely to the fact that other industries are offering better opportunities, but is more or less influenced by the growth of industry in general being faster than the supply of trained men can keep pace with. Nevertheless, one industry in particular is taking from us many of our brightest young men, and is taking them almost entirely because of wages. Granting, then, that conditions will remain practically as they are, the only method by which we will keep the personnel of our particular industry in the highest class is by the offering of greater wages. The mere act of holding a job has ceased to be the all-important inducement.

### Inefficiency of Workmen

Whenever the word "efficient" or "inefficient" has been used as applying to our line of work, the natural tendency has been for all minds to turn to the shop end of the business, especially to the man who runs a machine. Practically all of the illustrations by means of which our eminent experts have arrested the attention and gained a permanent lease of the ears of managers and board of directors have had to do with such perfectly awful incidents as a shaper tool taking a 5-inch stroke when a 3½-inch stroke would have been sufficient. I hold no brief for the man who cuts air when he should cut metal, but to my mind it is no more than right that we should first look to ourselves to see wherein we fall short of the mark of 100 per cent. If the workman is not efficient, just what is our share of the cause of his inefficiency?

First, let me say, that it is my firm belief that the large majority (if I were to state a percentage I would say 90 per cent) of all machinists employed by the National Machine Tool Builders' Association, are endeavoring to give an honest day's work. That they do not produce more work than at present is largely the employer's fault—so much so that it is going to take the whole of his attention to certain details before he can induce his men, and hence himself, to earn more money. I am saying this from a mind that only a comparatively few years ago looked at the workman's side only of this question. I am not so far away from the operation of a machine that my memory has become dulled to what went on when I was trying to produce against obstructions allowed to stand in my way by my foreman and his superiors.

The metal cutters, or chip makers, on the simpler class of work, may be assumed to be fairly efficient in most of our shops. It has been a comparatively easy matter to set standard times or prices on these operations. There is still a good field for improvement in the making of drawings, especially for the workman's use. I'll venture to say that in every one of our shops today there are blueprints that the "old man" himself would not recognize as showing a part of his own inventions, if someone should cut the title corner off, and as for settling where the machining should begin he would have to lose a good many minutes in study. Even the simpler

drawings are a puzzle to the beginner and the foreman cannot be in all places at once. We should point out, on our drawings, by the copious use of English and by means of routing sheets, just what the workman is expected to do. Most of the shops that I have seen are open to this criticism: We are all drifting along, to some extent at least, in the old way of leaving a workman to his own initiative to find ways and means of doing a great share of the operations. The draftsman who learns to make drawings with the idea of saving time in the shop gradually makes of himself an engineer in the true sense of the word, because in order to tell how a piece should be made, he first has to learn by consulting with those who do know. He is inducing himself to earn more money. The foreman who is fortunate enough to have his blueprints come to him in such form that the more intelligent of his men need little personal instruction and supervision has more time to devote to the weaker members of his gang and his department output is higher—consequently, his own value increases.

### Putting the Workman in Business for Himself

Right in line with this plan I recently tried an experiment that is interesting because it is illustrative of exactly what is going on in many shops, and is causing the loss of a lot of money. A quantity of a certain small piece was sent to us by another firm to be ground. We had quoted on the work and there was a price we had to meet. As usual, in such cases, before letting the work start in the shop we sent along with the pieces a routing sheet, which told how many pieces per hour we had estimated to be a fair production. The pieces were produced inside of the time limit and the net cost per piece was 1½ cent. Several months later a lot of the same pieces came in, and these were put into the shop and ground by the same man, but without anything to tell him what was expected of him. The second lot cost 2 cents each. Now the operator was not dishonest. I do not believe that he intentionally held back. He simply wasn't in business for himself. He would have produced those pieces for 1½ cent if there had been any means supplied for concentrating his mind on the job. Even if he had run into an obstacle that he couldn't overcome, he would have called for help quickly, in order to protect his own record. As it was, the time drifted by without his having a very clear idea of anything in particular. You have to get the man interested, and there's only one way—put him into business for himself. How this is to be done, whether by premium or by piece-work, matters little, provided you see to it that more product means more wages. There is just this much about it—those who stick to a straight-day work system, unless ways are devised for periodically rewarding increased efficiency, will lose their men to the shops that succeed in putting every man into business for himself.

I know of a shop that has reduced the cost of erecting its machines as shown by the following table, by doing two things: first, by giving up the old, slipshod method of starting to erect before everything was ready, and second by putting the assemblers into business by giving them a generous bonus for speed.

Machine	Old Cost, Average	New Cost, Average	Machine	Old Cost, Average	New Cost, Average
No. 1	\$43.73	\$22.62	No. 4	\$36.78	\$18.25
No. 2	45.01	19.78	No. 5	41.26	18.84
No. 3	45.21	18.26	No. 6	32.35	18.97

The bulk of this reduction was due to the fact that all the parts were ready before the erecting was started, but a lot of the saving came from putting the men into business. Where they were formerly paid \$3 a day, at day rates, they now earn about \$4.50 per day, and it would be a difficult task to try to hire one of those men to go back to the old \$3 job, even if he were guaranteed less exertion per ten hours.

An incident reported to me by the foreman of that job shows how it works out. He overheard one of the assemblers

\* Paper read before the National Machine Tool Builders' Association convention, Worcester, Mass., April 23, 1914.

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using rather forceful language to a truckman. It seems that the truckman had been sent to the stores to get a certain mechanism that was to be the next one to go onto the machine. He arrived there at about six o'clock, and, as the mechanism was covered with an anti-rust compound, the stores boy, not wishing to have to wash his hands again, put him off with some excuse. The truckman went back with an empty truck and the conversation overheard by the foreman was the result. I cannot, for obvious reasons, quote verbatim what he told the truckman, but the gist of it was to get back to the stores with word that the mechanism had to be at the machine ready to be used at seven o'clock the next day or something unpleasant would happen. That assembler was in business for himself.

Another incident: A lot of gears were being machined at the turret lathe. The operator could, ordinarily, make good pay at ten cents each. The foundry had evidently made the gears of iron that was intended for larger work. They were hard. Under the old methods it would be only by accident that this fact would be discovered before the job was completed. In this particular case the workman appealed to his foreman who took the matter up with the superintendent. The result was that the foundry acknowledged its error, paid for the amount the operator ran behind, and the expense was put where it belonged.

An operator noticed that some bars in a lot of tool steel machined much more rapidly than others. His insistence on having all the bars good ones led to a thorough investigation and the formulation of specifications for tool steel that now enable that firm to form three-inch diameter tool steel bars with tools three inches wide at a surface speed of over 100 feet per minute.

The firm from whose experience these incidents have been cited believes that the best way to put a man into business so that he can share profits on each job he does is to have a rate setting department that is made up of good operators, under the leadership of a man who is himself capable of taking hold of any productive job in the works. It is almost always found to be a fact that a careful study of a job, not by the stop watch, but by actually doing it, leads to improvement. Sometimes there is only a slight gain. In other cases the time has been reduced to one-third of what it formerly was. The rates are set on the principle that since it has been found possible to reduce the cost and the concern was satisfied with that cost, before this discovery, then the new rate can be placed well above what it actually can be done for. This is contrary to the old spirit of management, but is right in line with what most machine tool men at least believe, and is the only way you can get your men into business for themselves.

#### Efficiency Movement on a Common Sense Basis

In this connection I do not wish to be understood when I mention the stop watch as not agreeing that oftentimes facts can be learned and gains made through the medium of so-called "efficiency" workers, who are themselves perhaps incapable of performing the operations, but who are intelligent observers. What I do mean is that I personally believe that greater savings are to be made by having a skilled man study the job from an inventor's standpoint rather than from that of a recorder or historian. All interferences with production are not evident to a mere observer. Most of them hark back to the design or to conditions imposed by the relations of a given piece to others in the same machine. The "efficiency" movement, like many other great movements, has its quacks who seize the time of unrest to play upon the credulous ignorant. But every one of us should be thankful for the impetus given to our minds by the crusade definitely started by F. W. Taylor. The obtaining of the benefits of this common sense scheme need not cost anything. In fact, it can be made to pay almost from the beginning. One good man can do enough for a group of men in so short a time that the extra production of the group will pay not only for the money spent on them, but also for further work with other groups. The scheme, properly conducted on a common sense basis, without frills, soon is compounding its gains. Such a movement, to be successful, requires the hearty back-

ing of the management, for there will always be men in every organization, perfectly honest in their view, who are unable to see beyond the tips of their own noses when it comes to making a change from the established order of things. A management that will accept, without considering it a personal affront, the statement that it is not as efficient as it could easily be made, and at the same time is so constituted mentally that it is eager to share with the producer in any saving that may be made, will easily find ways to reduce cost, and need have no fear of being unable to get good men or to keep them loyal.

#### Educating Men in the Value of Materials

Men are more often careless through ignorance than by nature or intent. The man who spoils a piece of work knows that he has destroyed value, but to him the time lost is usually the item that appears to be the most important. Men should be educated in the total value of the goods they handle. They should know the cost of materials and approximately the shop burden. I know one superintendent who has adopted the system of having all spoiled work reported to him on a card that states the fault and the number of pieces spoiled. Whenever the case is of enough importance to attract his attention, he makes it the excuse for a friendly talk with the man who did the job. He talks the affair over in a way that brings out both sides of the case. Before he lets go of that incident he has taught that man a whole lot about what it costs to carry the burden of a business. He has done more good than any "call down" would do, and he has strengthened the workman's loyalty to the firm, and this, without saying, includes a determination to spoil no more if he can help it.

Discharge should be the last resort, and a frequent use, under ordinary conditions, of the power of discharge, for any reason other than the lack of work, is the sign of poor shop management. Under the management that finds its main corrective in discharge, the new man will be at a still further disadvantage because he will not have had the experience that caused the downfall of his predecessor.

#### The Foreman as an Executive

Now and then you will find a foreman who is a natural born business man, but this kind is rare, as foremen are usually promoted to their positions because they are good workmen, and not because of the other qualities that a foreman should have. There is a lot of difference between being a good workman and being a good executive. Most foremen have no definite idea of the cost of anything, except net labor, and it is not their fault either. Management rarely interests itself in a foreman to the extent of trying to make a real business man out of him. Yet the returns are well worth the effort. Just start a scheme whereby your foreman really runs his own department, and knows exactly where every cent was spent for which he was responsible, and you will find a most interested and watchful lot of men. You will find that having the entire list of officers on the alert for economy is way ahead of trying to do all the worrying yourself, about the time the cost department reports the facts, which is several weeks after the damage is done.

At the Norton Grinding Co. we keep an account against each foreman and gang boss, of all of the expenses for which he is directly responsible, that is, repairs and replacements, supplies, non-productive labor, spoiled work, etc. Such items as taxes, rent, power, etc., are, of course, not considered, as he has no direct control over them. The total of his expenses divided by the total of his productive labor gives what we, for the sake of comparison, call the overhead of his department. At the end of the month he is given by the cost department all of his supply requisitions with the costs marked in, and all through the month, if another foreman does for him any non-productive job, such as repairing a machine or grinding a cutter, a duplicate of the time card is sent to him with the total money cost showing. This system has aroused more interest among the foremen than any scheme we have yet found.

One foreman found that he was being charged \$10 per week for trucking, the truckmen, up to that time, being responsible

to the head inspector, and responding to calls much the same as the bell boy plan in a hotel. The foreman kept careful record for a few weeks, and then made the announcement to me that his trucking was worth only \$6 per week, and that he didn't want to pay \$10 for it. The result was that we took one truckman away from the inspector and put him at productive work in the casting department, and the foreman hired a cheaper man to do simple productive work some of the time and trucking when it was needed.

Another foreman came to me with a milling cutter and said, "We make cutter grinders for sale. How much time would you tell a customer that it would take to grind this?" I knew something was up, so I was conservative. My estimate was that it ought not to take over two hours. He thereupon produced a charge by another foreman of sixteen hours for the job. We both made a trip to see the other foreman with the result that the charge was reduced to two hours, which all agreed was ample. The foreman who had done the job was charged with fourteen hours of spoiled work, and the grinder operator was given his notice because his foreman said this was simply the climax of several such incidents, and he had failed to show any interest.

Even second-hand belting suddenly assumed great importance. I did not, at first, foresee that hairs would be split so fine, but it did not take long before a foreman wanted to know what became of a certain belt that was taken out of his department and replaced by a new one. I told him the good part of it would be spliced to another piece and used again. He wanted to know if I didn't think he ought to have credit. So now, when we take an old belt out, if the man in charge of belting says the bulk of it can be used again, after cleaning and repairing, we credit the department with one-half the price of a new belt. When we use that belt again, we charge the department getting it with one half the price of a new belt. Cotton waste is down to one-quarter pound per week per man using waste, and belting is down to \$18 per month, average, for the whole shop, where there are 1160 belts in almost constant use every working day.

The foremen are enthusiastic over the scheme. One foreman said, "Sure, I like it. It teaches me so much about my job that if you don't treat me right I can go to someone else and tell him just how much I can run a department for, including my own wages." That is just the position we want him to be in, because we, being on the inside, know all about him, and ought to be able to keep him, if we consider him worth keeping. If, by poor judgment, on our part, he leaves and is really worth more, then we can rejoice with him.

#### Duties of the Superintendent

The superintendent should never be too busy to take care of any matter that the foremen or workmen think is important, whether or not it is firm's business or personal, and he should be a man in whose word the men have confidence. His training and his actions should be such that the men will know that he is not asking anything unreasonable or that he would not do himself. He must be an enthusiast in his business. He must be a boy with the boys, in fact, he must never forget to be a boy at heart. All first-class enthusiasts are. He must always be on the lookout for good qualities in men. He must campaign for loyalty, a shop's best asset, just as the nation, through the public schools, campaigns for patriotism, for both are the result of plan and not of accident. Loyalty, like patriotism, is spontaneous only in times of intense emotion. It has to be created and fostered by well laid plans that have for their fundamental principle the giving of value for value received.

The superintendent must have the cooperation of the management in teaching the so-called "non-producer" that the business of capital is to make dividends, and that the only excuse for his particular "non-productive" existence is to help "productive" labor to make more chips or to get something assembled faster or better, and that the closing of his day's duties at a certain hour is merely an unimportant incident instead of being the great event that tradition has made it.

#### Misunderstanding between Employer and Employees

Before we leave this subject of loyalty, it seems necessary to me that I should broach a topic that is usually tabooed in open meeting, but it is one which, to my mind, should be dis-

cussed openly, as it has to do directly with the earning power of all workmen who become infected. I refer to unionism as it is now conducted. What are we doing to combat or counteract it? Practically nothing that will have a permanent effect. The opposing of strikes by means of strike breakers and by any other combative means within our power is simply the expedient of necessity and is costly to both sides. We must get at the question through the education of the individual. Practically nothing is being done in this line. The machinist who knows absolutely that there is nothing for him in unionism, as it is today conducted, learned it only by costly experience. It is going to take too long for all men to be educated by that method.

The manufacturer has thus far stood between the union and the public, and has been discredited by the public because the public has been left practically ignorant of the employer's side of the question. The other side of the question sells more newspapers, the people hear all about that side and many untruths about the other.

If all workmen could know, today, the burden that shop owners have been carrying and are carrying in the problem of how to keep their men at work during this period of depressed business, there would be a great many men who would not stop to listen to the agitator when he starts in again. That these men do not know such facts as this is our misfortune, and it is my belief that we have every right to uncover such facts and especially to educate our men to such an understanding of business conditions that they will cease to listen seriously to many of the wild statements made on the street. For instance, in Fitchburg, during the machinists' strike, the daily papers quoted a union leader as saying something like this: "You fellows average to get \$2.50 a day. You average to produce \$10.00 a day. The man in the automobile gets \$7.50 a day out of each of you." Now that statement was allowed to stand, and I believe that many of that man's hearers accepted it as being practically true.

Those who can remember back, if they were so fortunate as to have the privilege of learning a trade, can also recall a time when that man would have arrested their attention, and if they had not followed him, it would simply have been because they had other ideas about what they were after, and not because his statement appeared to be so very far wrong. The employer has not taken the trouble, through well planned intelligent means to teach the workman that net labor is not the great item in an industry. He thinks it is a serious sin to mention the word "overhead" outside of the office. He has not actually proved to anybody, but himself, that if a machinist gets \$2.50 a day and only produces \$10 worth of salable goods in the heavy lines of machinery, such as are made in Fitchburg, the "man in the automobile," in a good many cases, would lose money. This kind of education should be spread broadcast. It is not a dream to think that it would be good for a high school boy to know something of the "overhead" of education and of business, just as the engineering schools, notably the Worcester Polytechnic Institute, are teaching it. Trained men should address workmen, in front of the shops, if you like, and the public at every possible opportunity, in an endeavor to clear the workman's mind of the ignorance that continually works against his own advancement. Employers already issue several very good papers for this purpose, but those papers are confined, in their circulation, almost entirely to men who already believe in that side of the question. These papers should be put into the hands of every man in the shops, and would do a whole lot of good in the hands of men outside of the machine tool trade. The printed matter should be followed up by intelligent, enthusiastic effort to convert men to the right way of thinking. Men must be taught that although they have rights every right entails a duty to the community, and the service must be rendered before the right can be justly claimed. It is about time that the sane men of this country who hire labor take hold of this question in an honest endeavor to get together with the sane men of this country who have labor for sale, instead of leaving this important duty to labor leaders who would lose their jobs if they ever really did succeed in doing what they claim to be trying to do—that is, get us together.

## NORTON SAFETY FIRST ASSOCIATION

In view of the fact that the question of safety is becoming more vital and more widely recognized the world over, it may be of interest to note the steps that have been taken by the Norton Co. and the Norton Grinding Co. to further this movement in their plants.

A "Safety First" association was formally organized among the officials and workmen of the Norton Co. and the Norton Grinding Co., March 20. At the organization meeting there were present all the foremen and assistant foremen of both companies, as well as one workman from each department. The first safety work in the factory of the Norton Co. began in March, 1909, when a safety committee was organized. This committee was composed of five members, four being heads of departments, and one a member of the engineering department, who made monthly inspections of the plant and subsequent recommendations. The result of their work has been that practically all dangerous places in the plant have been guarded and a great many accidents have been prevented. That the work of the safety committee has been thorough is proved by the fact that on investigation of the causes of all accidents reported to the Norton hospital it has been found that very few can be attributed to the lack of mechanical safeguards. The safety committees of the Norton Co. and the Norton Grinding Co. will continue this work as they have in the years past, and will enter into the "Safety First" association, being designated by the constitution as the permanent executive committee.

A study of the accidents that happened in the plants of both companies showed that they were almost always due either to inevitable risks or to carelessness. Further study

showed that if the accidents caused by carelessness could be eliminated those remaining would be almost insignificant in number. With this in mind the safety committees of the Norton Co. and the Norton Grinding Co. were called together for the purpose of organizing a safety educational campaign. After several meetings the following plan of procedure was recommended and has been carried out.

First, to establish a standard for all mechanical safeguards, a book of standard safety specifications was given to all foremen, draftsmen, inspectors and others who have occasion to order machinery of any kind. Second, a book of safety rules for workmen was drawn up, and each man who learns the rules to the satisfaction of the committee is made a member of the Norton "Safety First" association, and is given a button. This society holds social meetings at which discussion of safety topics forms part of the program. Only members wearing buttons are admitted. Third, a set of safety rules for foremen was adopted, which was issued to each foreman and assistants. Fourth, to assist the foremen in enforcing the safety rules, a safety inspector was appointed in each department, whose duty it is to report any one whom he sees violating the safety rules or any dangerous conditions which he observes in his department. These inspectors wear a special button as a badge of authority and an official notice of their appointment is posted in each department. To introduce the subject to the men, the words, "Safety First" were printed in large letters on the pay envelopes. This prompted the men to ask what these words meant. After two issues of such pay envelopes, large placards printed in English, Swedish and Italian, as shown in the accompanying illustration, were posted in various parts of the works, which gave a short explanation of "Safety First." An announcement of the proposed organization was also published in the monthly *Health and Safety* bulletin, issued by the health and sanitation department. No attempt has been made to coerce the men into joining, but the response of the workmen to the invitation has been prompt and many from all departments have already qualified as members. Following are the safety rules issued for the foremen:

### Safety Rules for Foremen

Learn all safety rules for workmen. You will be held responsible for the enforcement of all these rules in your department.

When you hire a new man, you must explain to him all safety rules in connection with his work.

When you put a man onto a new class of work, explain to him all safety rules in connection with his new work.

Watch all new men carefully and see that they take no unnecessary risks.

You are responsible for keeping in place all safeguards in your department.

If a new machine is set up in your department, do not allow same to be started until you make sure that all gears and other dangerous parts are protected.

If a machine has been repaired, do not allow same to be started until guards have been replaced.

If a guard or safety device is out of order, do not use machine until it has been repaired.

Keep all passages in your department clear at all times.

Examine frequently all belts in your department and see to it that they are under the proper tension, also that lacings are in good condition.

See to it that all overhead work, shaft-hangers, etc., in your department are kept rigidly secured.

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The complexity of modern manufacturing conditions has led to the use of a variety of methods of transmitting power, each of which has its advantages for different installations. One advantage of rope drives is that this transmission is practically independent of the relative positions of the driving and driven shafts. Where shafts are at an angle to each other, the application of a rope drive does away with the necessity of using a quarter turn belt which is regarded as a troublesome problem in mill-wrighting. Regardless of the type of drive that is used, it is essential for the design to be worked out by an experienced engineer who is able to advise the most suitable method for the case in hand.

## SAFETY FIRST

What does this mean?

It means that SAFETY should be your FIRST thought always.

Never take any chances with your own or others' safety, for the sake of getting a little more work done, or saving a little time.

It NEVER pays in the end to TAKE CHANCES; You and your family are the ones who suffer.

It is ALWAYS best to think of SAFETY FIRST.

## Försiktighet Först

Hvad betyder detta?

Det betyder att FÖRSIKTIGHET bör alltid vara Eder FÖRSTA tanke och sträfvän.

Gör ingenting, som kan sätta Eder egen eller andras säkerhet på spel, i afsikt att få litet mera arbete gjordt eller vinna litet tid.

VÅGSAMHET i detta afseende BETALAR SIG ICKE, ty Ni sjelf och Eder familj äro de som bli lidande.

Det är därför alltid bäst att tänka: FÖRSIKTIGHET FÖRST!

## La Salvezza Prima

Che cosa significa ciò?

Significa che la salvezza deve essere sempre il vostro primo pensiero. Non cercate mai di azzardare la vostra o l'altrui salvezza, con la speranza di fare un poco di lavoro di piu, o per risparmiare un poco di tempo.

Infine non paga azzardare, giacchè voi e la vostra famiglia siete i soli a soffrire.

E' sempre buono pensare prima alla salvezza.

Norton Company

## MAKING WING NUTS IN A PUNCH PRESS

DIES, TOOLS AND METHODS USED IN MAKING A PATENTED TYPE OF WING NUT IN THE PUNCH PRESS

BY DOUGLAS T. HAMILTON\*

The utilization of a punch press for producing wing nuts may seem to be rather unusual—as it is—but as the following description shows, the operations are handled in a perfectly practical manner. The wing nut to be described is used largely on knock-down furniture and articles of a similar kind. The methods of manufacture are patented, the patent being held by R. Smith, general superintendent of the National Screw & Tack Co., Cleveland, Ohio, at whose plant

machine has sixteen elongated slots which conform in shape to the upset stock. This dial is filled by the operator, and as it is indexed, one blank at a time drops out and is located in fingers in the carrier *B*. The carrier moves the blank to a position over the first die and as the punch *C* descends, the blank is flattened in the center and slightly bent at the ends as shown at *C* in Fig. 1. The carrier *B* then picks up the blank and carries it to the next position. Here the blank is located over another flattening die and the punch *D* performs the final flattening operation on the center of the blank and at the same time bends up the ends a little further. This punch is provided with a conical impression in its lower face, which forms the sides or beveled portion on the center of the nut; it also has semicircular grooves

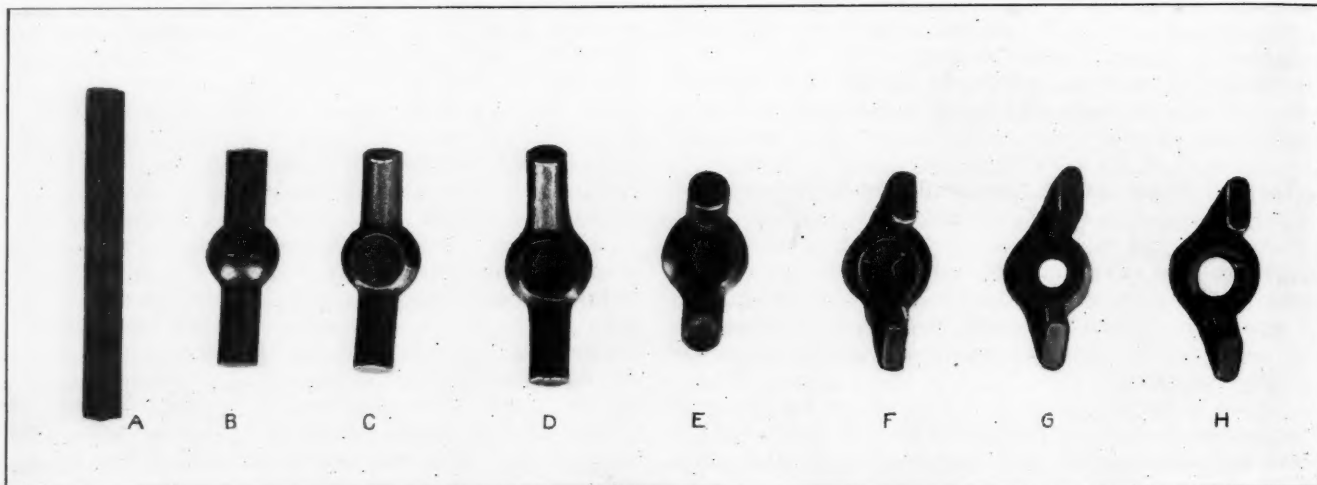


Fig. 1. Development of a Wing Nut in a Punch Press

this information was obtained. The wing nut is made from a cold-rolled coil of wire 0.248 inch in diameter, and is completed in seven operations, the first two being accomplished by one blow in a cold heading machine.

### Cutting Off and Upsetting the Stock for the Wing Nut

The first operation on the wing nut is to cut off a piece of wire  $2\frac{3}{32}$  inches long. This is accomplished in the Waterbury Farrel cold header illustrated in Fig. 2. The wire *A* is held on a reel and is drawn in to the cutting-off tool by means of rolls, cut off and then gripped and upset in



Fig. 2. Cutting and upsetting the Blank—First Operation on the Wing Nut

the center, as indicated at *B* in Fig. 1. The method of operating a machine of this type was described in the article entitled "Cold Heading—2" which appeared in the July, 1913, number of MACHINERY. This upsetting operation reduces the length of the cut-off stock from  $2\frac{3}{32}$  to  $1\frac{3}{8}$  inch, and at the same time increases the central portion or bulge on the stock to 0.460 inch diameter.

### Shaping the Body and Bending the Ends to Form the Wings

The next three operations on the wing nut, illustrated from *C* to *E* in Fig. 1, are accomplished in the punch press shown in Fig. 3. This machine has been arranged with a special dial and work-carrying mechanism similar in operation to the multiple plunger press described in the August, 1911, number of MACHINERY. The dial *A* located to the right of the

in its sides corresponding to the shape of the wire so that the wings can pass up by the punch. The result of this operation is shown at *D* in Fig. 1. The slide *B* which carries the blanks from one position to the next is operated by a crank motion that transmits a movement to the slide through arm *F*. The sequence of operations is progressive until the blank reaches the last position where it is forced through the die and drops into a box under the machine. Seventeen thousand of these wing nuts are turned out from this machine in ten hours.

### Flattening the Wings

Following the flattening of the body and the bending up of the wings, comes the flattening of the wings. This is accomplished in the punch press shown in Fig. 4. The operator lays the blank in a slide, operated by means of a crank motion, that carries the work to the flattening die. The work is carried forward with the two prongs or wings facing in toward the machine. This slide places the wings over the die and holds the blank in position until the punch descends and flattens the wings. Upon the return stroke, the flattened wing nut is ejected from the carrier and dropped into a box. Seventeen thousand blanks are turned out from this machine in ten hours.

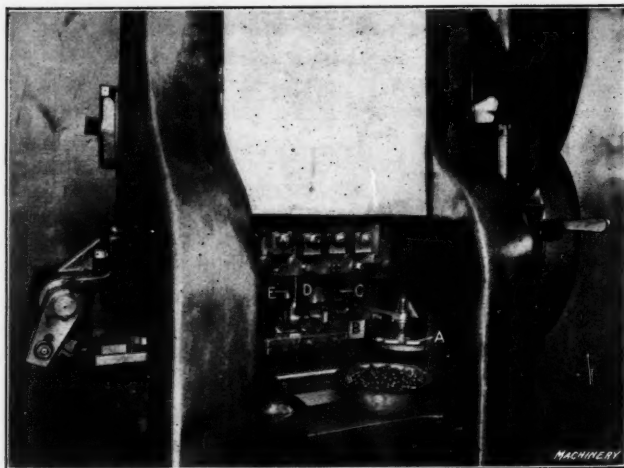


Fig. 3. A Progressive Punch Press Operation—Flattening and Bending the Wing Nut

\* Associate Editor of MACHINERY.

## Punching the Hole and Tapping

The hole is punched in the wing nut in the machine shown in Fig. 5; this is provided with a special work-holding device consisting of a stationary and a movable slide. The movable slide *A* is controlled by the lever *B*, and to insert the work this slide is drawn back, the nut placed in the cage and the slide returned to its clamped position. The press is then operated, and as the punch *C* descends it punches the hole in the nut. When the ram of the punch ascends, the operator again moves lever *B* outward, pulling back the slide, removes the punched wing nut and inserts an unpunched one in its place. The rated capacity of this machine is from 16,000 to 18,000 in ten hours.

The tapping of the wing nut is accomplished in the tapping machine shown in Fig. 6. This machine is provided with four spindles and carries long shank taps held in quick-

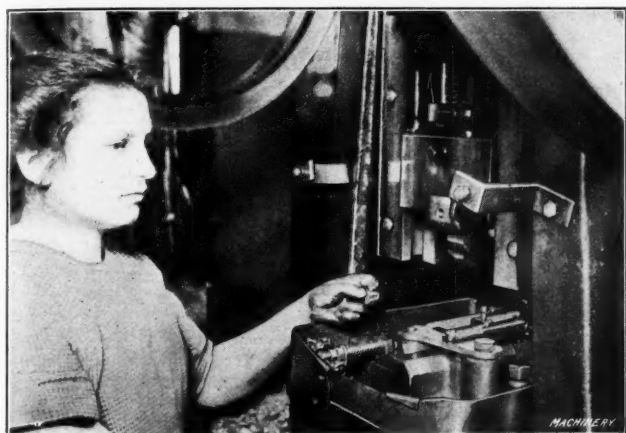


Fig. 4. Flattening the Wings of the Nuts

removing sockets. The operator places the wing nuts in cages and as the taps descend, they pass through the nuts, the latter traveling up on the shanks of the taps. When the shanks of the taps are filled they are removed, inverted so that the nuts drop out into a box, and then replaced in the collet.

\* \* \*

A public hearing was held by the United States Commission on Industrial Relations, in Washington, during the three days beginning April 13, for the consideration of efficiency systems and their effect on industrial relations. Witnesses were called by the commission to testify with special regard to the status of workmen under scientific management. Consulting engineers and employers who have led in the introduction of efficiency systems alternated with trade union officials in giving testimony. Among others who were re-

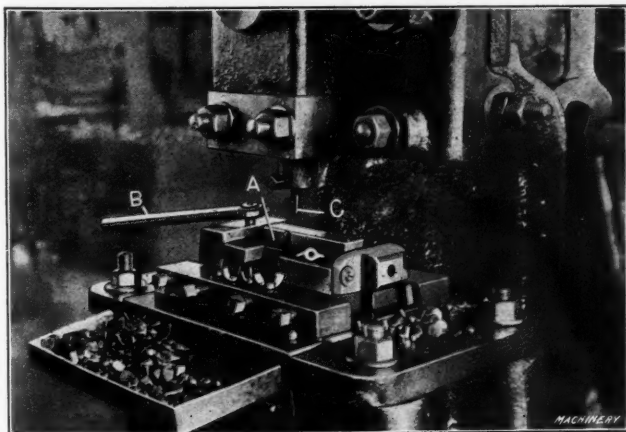


Fig. 5. Punching the Hole in the Wing Nut

quested to give their opinions were F. W. Taylor, who originated and developed the Taylor system of scientific management; James Duncan, first vice-president of the American Federation of Labor; Louis D. Brandeis, H. L. Gantt, Harrington Emerson and Carl G. Barth, consulting engineers; J. M. Dodge, president of the Link-Belt Co.; William H. Johnston, president of the International Association of Machinists; and A. L. Berres, secretary of the Metal Trades Department of the American Federation of Labor.

## APPLICATION OF A PROTECTIVE METAL SURFACE BY SPRAYING

BY J. OSBORNE\*

In many industries it is necessary to coat one metal with another. Hitherto such a coating has been applied by electrical deposition, but a process is now available by which one metal can be deposited upon another by mechanical means. It is claimed that the new method offers many advantages. The invention has been worked out by a Japanese metallurgist, and is especially designed for the coating of iron or steel with aluminum to prevent rusting. The process is a simple one. The metal surface to be protected is, in the first instance, galvanized or tinned; it is then immersed in molten aluminum under the surface of which it is scrubbed with steel wire brushes to remove the zinc or tin coating, which is replaced by the aluminum. The metal with its new coating is then ready for any processes through which it may have to pass, such as rolling, pressing, polishing.

Large castings or built-up iron or steel members cannot be subjected to the process just described. As it is often desirable to render structural steel work rustproof by means of a coating that is not easily corrodible, an alternative system has been worked out for this class of work, which may be briefly described as follows: The protective metal is, in the first instance, pulverized and is then forced by mechanical means into intimate contact with the surfaces which it is desired to protect. Molten lead can be readily pulverized by methods which have been known for three decades and have been very extensively used in the manufacture of electrical apparatus; the finely divided metal is applied in the form of a paste and pressed into grids to form the active material in accumulators. The stream of pulverized metal could also be directed onto plates made of some such material as asbestos,

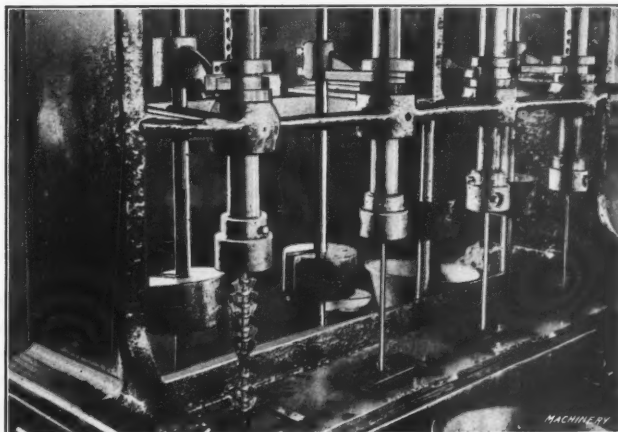


Fig. 6. Tapping the Hole in the Wing Nut

which is not sensitive to the action of sulphuric acid, so that these plates with their porous film of lead could be used without further preparation as accumulator plates.

This was the first step in the development of a process for the pulverization and spraying of metals. A steam boiler was first used for pulverizing and spraying the lead, high-pressure steam being delivered through a conveniently situated pipe and caused to impinge on the surface to be protected. Melted lead was injected into the path of this jet of steam from a suitable container, with the result that the lead became completely pulverized and was carried forward in that form by the steam and thrown against the surface to be coated with sufficient force to make it adhere. The process was then carried a step further. An apparatus was designed to enable jets of oxygen and hydrogen to be obtained at a high speed and ignited at the point of emergence, in that way forming practically an oxy-hydrogen blowpipe, capable of melting a portion of the metal held in the flame and at the same time pulverizing it and throwing forward the pulverized particles under pressure. The pulverized metal was directed against the surface to be coated. Now if means can be provided by which the pulverized metal will be fed at the desired rate, a spraying apparatus will be ob-

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tained by means of which even substances fusible with difficulty can be worked easily and continuously.

There is the alternative of using an electric arc, should the heat of the oxy-hydrogen blowpipe be insufficient. The electrodes are made in the form of hollow carbon rods; they melt off the metal used for the protective coating and this melted metal is carried forward by a highly heated or burning stream of gas passing through the hollow electrodes. In practice, the idea just outlined is carried out by means of an extremely compact little apparatus in which the compressed gas, before it is used for pulverizing the metal, first operates a miniature air turbine, the rotation of which determines the rate of feed of the metal in exact accordance with its consumption. The thickness of the deposit may be anywhere from a few thousandths inch up to half an inch or more, according to the duration of the period of treatment, while the density of the deposit can be varied. Thus a lead covering which was sprayed with superheated steam had a specific gravity of 9.5, while another lead coating sprayed under similar conditions by means of hydrogen had a specific gravity of 11 to 11.3.

It has been ascertained that, for a given pressure, hydrogen possesses a much higher velocity of flow than superheated steam, and so the pulverized metal is projected by it with proportionately greater energy. This increase of energy is proportional to the square of the velocity and, knowing this, it is possible to vary the velocity to obtain a density of the coating suitable for any particular purpose. The hardness of the sprayed coating is usually considerably more than that of the cast metal and, indeed, in many cases which have come under observation, it is even equal to that of a rolled sheet. The manufacture of metal coatings by this process should be found useful in the electrical industry. To give an instance, very thin sprayed strips should come into use as electrical resistances for all classes of electrical heating apparatus, and, as a matter of fact, the heating element in such apparatus has already been made in extremely thin layers of the more costly metals, which are painted on in the form of salts that are subsequently reduced to metals. Such strips offer a very high resistance to the passage of the current and therefore become incandescent very rapidly.

The process described is available for coppering carbon brushes and the ends of electrodes, and for the production of contacts. The spraying of two adjacent surfaces at the interstice formed at the point of contact causes this to be entirely filled up, thus providing a perfect union of the two bodies. It also facilitates mending a cracked or broken surface, so that a simple substitute for soldering and welding processes is provided. Another important application is that of galvanizing iron of irregular section used for structural work. Aluminum—the single metal that so far has not been available for treatment by electric deposition—can now be utilized by means of the spraying process. It has been suggested that sprayed aluminum could be used for coating aeronautical fabrics to render them air-tight, also for the coating of the wooden frames and fabrics of aeroplanes for the purpose of protecting them against the weather; it would, in addition, increase their stability. The coating of wood with metal is a novel idea and its application has many possibilities. Wooden parts protected in this way would be insured against dampness and rotting, or in the tropics, against damage done by insects. Packing cases could easily be strengthened by spraying the edges, or the boxes could be sprayed all over to exclude dampness.

\* \* \*

An electrical instrument has been developed that promises to be of considerable value to electric light and power companies, inasmuch as it will enable them to sell current at two rates and to measure it at the rush and slack hours with the same meter. The device responds to a momentary slightly higher current wave than normal and it shifts the meter from one rate of register to the other. Thus, when the lighting load is heaviest in the early evening, the meter is set to register at the high rate but when the demand falls off after midnight, the wave impressed on the circuit shifts the meter to register at the lower rate.

## IMPORTANCE OF PURITY OF OXYGEN USED IN CUTTING STEEL

BY J. F. SPRINGER\*

The cutting of steel by means of the torches employed in autogeneous welding may be divided into two rival procedures. These differ principally in respect to the generation of the heating flame, one employing the oxy-hydrogen and the other the oxy-acetylene flame. In some respects, cutting with the hydrogen flame is to be preferred. In most cases, however, either will accomplish the desired result with economy and despatch.

### Impurity of Oxygen

It is of considerable importance to understand the effect of impure oxygen. The impurities which have any especial claim to attention are those which arise through the presence of nitrogen or hydrogen. If the oxygen is prepared by the liquefaction of air, some percentage of nitrogen will be

very sure to be present. Nitrogen itself seems to be harmless, in so far as any ill effect on the metal is concerned. It is, however, practically unburnable, and so clogs the action of the oxygen. It probably also tends to cool the heating flame and thus retard the work. In the manufacture of oxygen by the electrolytic process, the principal impurity will probably be hydrogen. As hydrogen is a gas that is readily combustible it has but little effect on the heating flame, but in the cutting stream of oxygen its presence doubtless gives rise to a clogging effect similar to that of nitrogen. At all events, whether we account for the result in one way or another, the presence of nitrogen or other impurities in the oxygen supply has the effect of retarding the cutting operation.

This retardation means a labor loss in addition to a gas loss, besides hindering output. Certain experiments carried out abroad will assist us in seeing just how serious the retardation is. Table I gives the results of twenty-six experiments, all tried on sheets of the same kind, of the same thickness, and with the same style of torch.

It will be seen at once that the purity of the oxygen plays a most important part in the efficiency with which cutting

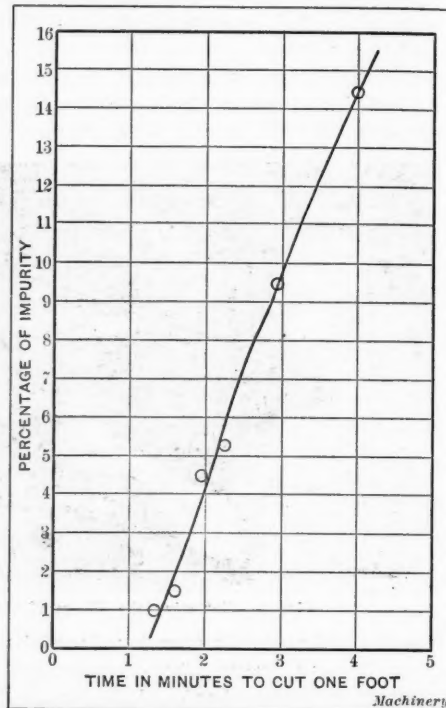


Fig. 1. Showing the Effect of Impure Oxygen on Oxy-Hydrogen Cutting

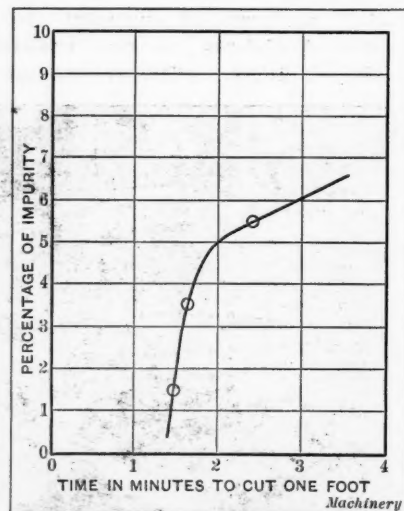


Fig. 2. Showing the Effect of Impure Oxygen on Oxy-acetylene Cutting

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TABLE I. TIME REQUIRED FOR OXY-HYDROGEN CUTTING OF METALS

Siemens-Martin sheet steel, 1.18 inch thick. Oxy-hydrogen procedure. Gas consumption per minute: Hydrogen, 1.06 cubic foot; oxygen, 0.28 cubic foot. Oxygen pressure = 1.5 atmosphere = 22 pounds per square inch.

Purity of Oxygen, expressed as Percentage	Length of Cut, in Inches	Time required in Making Cut, in Seconds	Time required to Cut One Foot, in Minutes	Average Time required to Cut One Foot, in Minutes
99.00	28.0	182	1.80	1.80
99.00	21.3	140	1.81	
99.00	18.9	120	1.87	
99.00	34.3	228	1.83	
99.00	29.9	196	1.81	
98.50	31.5	210	1.83	1.52
98.50	41.7	330	1.58	
98.50	41.7	320	1.53	
98.50	39.4	310	1.53	
98.50	27.6	225	1.63	
98.50	18.9	150	1.53	
95.50	44.5	426	1.91	1.91
95.50	32.3	295	1.91	
94.75	25.2	270	2.14	2.21
94.75	21.7	240	2.21	
94.75	33.9	364	2.15	
94.75	23.6	270	2.29	
94.75	41.6	475	2.28	
90.50	34.3	480	2.80	2.88
90.50	36.6	500	2.73	
90.50	32.7	480	2.94	
90.50	35.4	495	2.80	
90.50	29.9	470	3.14	
85.50	43.3	870	4.02	3.99
85.50	21.7	420	3.87	
85.50	23.6	480	4.07	

Machinery

may be accomplished. With oxygen 85.5 per cent pure, it requires three times as long to cut the 1.18-inch plate as with oxygen 99 per cent pure. This means that the cost is three times as much. Even the one-half of one per cent drop from the 99.0 per cent oxygen to the 98.5 per cent quality means an increase in the expense amounting to 16 per cent. So even if the better grade of oxygen should cost more, we see from the foregoing that it would have to cost a great deal more to make it a matter of no importance which grade of oxygen were used.

In Table II the same kind of steel and the same thickness of sheets are to be understood as in Table I. The pressure of the oxygen is increased, however. Note especially that here we have the alternative procedure with acetylene gas.

It will be noted that we do not have any experiments here

TABLE II. TIME REQUIRED FOR OXY-ACETYLENE CUTTING OF METALS

Siemens-Martin sheet steel, 1.18 inch thick. Oxy-acetylene procedure. Acetylene consumption per minute: 0.153 cubic foot. Oxygen pressure: 2 atmospheres = 29.4 pounds per square inch.

Purity of Oxygen, expressed as Percentage	Length of Cut, in Inches	Time required in Making Cut, in Seconds	Time required to Cut One Foot, in Minutes	Average Time required to Cut One Foot, in Minutes
98.50	17.3	123	1.42	1.40
98.50	28.3	192	1.36	
98.50	32.3	228	1.41	
98.50	33.9	230	1.36	
98.50	28.3	200	1.41	
98.50	28.3	202	1.43	
96.50	33.9	255	1.50	1.63
96.50	45.3	360	1.59	
96.50	47.2	380	1.61	
96.50	37.8	320	1.69	
96.50	58.3	480	1.65	
96.50	44.1	370	1.68	
96.50	41.7	340	1.63	
96.50	30.7	245	1.60	
96.50	41.9	380	1.69	
94.50	34.6	400	2.31	2.33
94.50	43.3	510	2.36	
94.50	43.3	520	2.40	
94.50	35.4	400	2.26	

Machinery

with 99 per cent oxygen. Comparing the 98.5 per cent purities in Tables I and II, we see that the acetylene cutting has the advantage. The result with 94.75 per cent oxygen, hydrogen cutting, when compared with the work done with 94.50 per cent, acetylene cutting, indicates that the efficiencies at this degree of impurity are about the same. This would become clearer by drawing curves illustrative of the last columns in Tables I and II. It must be borne in mind, however, that the oxygen pressure is distinctly higher with the acetylene experiments.

\* \* \*

## HIGH PRESSURES

Cold iron can be made to flow like molasses, providing the pressure on it be great enough. Many may not have seen it do so, but it is stated in the *English Mechanic and World of Science* that the late Sir William Roberts Austen, who was then Master of the Mint in London, once made a public exhibition of this phenomenon before an audience at the Royal Institution. He subjected iron to great hydraulic pressure and by an optical device he threw the image of the iron, at the point where the pressure was applied, on the screen, and the solid iron was seen to flow slowly, it being extruded through a small aperture. Investigations with very high pressures have lately been made by Dr. Bridgeman of the physical laboratory at Harvard University, and he has probably been experimenting with higher pressures than have ever before been reached. In some of his experiments he obtained a pressure of something like 300,000 pounds per square inch, and succeeded in measuring the pressure with reasonable accuracy up to 175,000 pounds per square inch. What these pressures mean will be understood when we consider that the highest pressures commonly produced are those exerted by the explosions in modern arms with smokeless powder, where a pressure up to 30,000 pounds or more per square inch is developed when the gun is fired. Pressures of 200,000 pounds per square inch have been produced by exploding nitro-glycerine in a closed vessel.

\* \* \*

Not all improvements in working conditions are appreciated by men who have become accustomed to those that appear to others as being intolerable. An example showing the effect of imagination is of interest in this connection. A basement lighted artificially had been used as a casting cleaning and snagging room. The working conditions were abnormally bad. The floor was damp, no windows permitted daylight to enter and dust removal apparatus had not been provided. Consequently, the air was filled with dust and grit but the workmen could not see the dust. The superintendent fitted up a floor in a new building above ground with exhausters and removed part of the cleaning force to it, but the men soon became dissatisfied and clamored to go back to the basement. They said that the dust in the new place would soon kill them. The fact, of course, was that the dust was much worse in the basement but being more visible in the new place because of being lighted by the sun, they imagined that they were being choked and injured by it. The superintendent was able to make use of the new department only by placing men in it hired to take the places of the old ones as they left. These, being unaccustomed to the former conditions, had no fault to find.

\* \* \*

No other feat in the history of the oil industry has equalled the killing of the wild gas well near Oil City, La., that has been wasting from 10,000,000 to 20,000,000 cubic feet of gas a day for the last six years. This great loss was stopped by the boring of a relief well close to the old one. When this well reached the same depth, water and then mud was forced into the relief well under heavy air pressure. This soon choked the gas stratum and shut off the flow. The work was done under the direction of the Louisiana State Conservation Commission which furnished a portion of the funds for the work. The remainder was furnished by gas and oil companies operating in the district. As soon as the flow of gas had been stopped, the well was cemented. The well had made a crater 225 feet in diameter and 50 feet deep.—*Compressed Air*

## WHY CENTER THE HOB?\*

CAUSES OF THE PRODUCTION OF FLATS AND METHODS OF PREVENTION

BY JOHN EDGAR†

**W**HETHER or not it is necessary to center the hob in order to get satisfactory results, is a question that is not so readily answered as it might appear. For the sake of making the matter clear to those who have not the time to make a study of the subject, the results of an investigation conducted by the writer will no doubt be of interest. Theoretically speaking, these results should show no difference whether the hob is centered or not. However, practical modifications enter into the actual conditions and

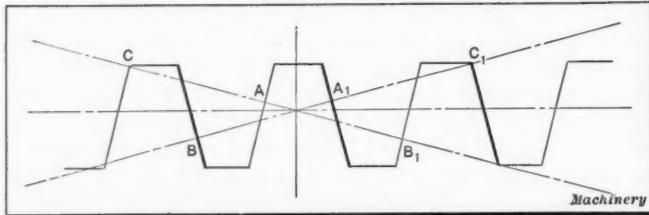


Fig. 1. Diagram showing Points of Intersection of the Pressure Lines with the Hob Teeth equally spaced at each Side of the Pitch Point

exert peculiar effects upon results produced. To briefly explain the action of the hob, we may say that the generating operation consists of a successive trimming of the teeth of the gear by those cutting edges of the hob located in the generating path. The portion of the cutting edge that forms the tooth of the gear lies on the pressure line of the hob, intersecting the pitch point, and the maximum length of the hob in this generating space is  $2s \div \tan \phi$ , where  $s$  = addendum or reciprocal of diametral pitch and  $\phi$  = pressure angle; in the cases of the small pinions this length may be as short as the circular pitch of the teeth.

The point where the two opposite pressure lines cross the pitch line is the center of the hob, and the object of centering is to get corresponding portions of the generating edges at equal distances on each side of the center, so that the sides of the teeth generated will be symmetrical. Thus in Fig. 1, the points where the pressure lines intersect the teeth of the hob at  $A, A_1, B, B_1$ , and  $C, C_1$ , are at an equal distance on each side of the center or pitch point, and at a like distance from the axis of the hob when the pitch point lies in the center of a tooth or space as shown. If the pitch point is shifted out of the center of the tooth or space, the radial distances of the respective points of intersection are not equal, the points  $A, B$  and  $C$  being a greater or less distance from the axis than the points  $A_1, B_1$  and  $C_1$ .

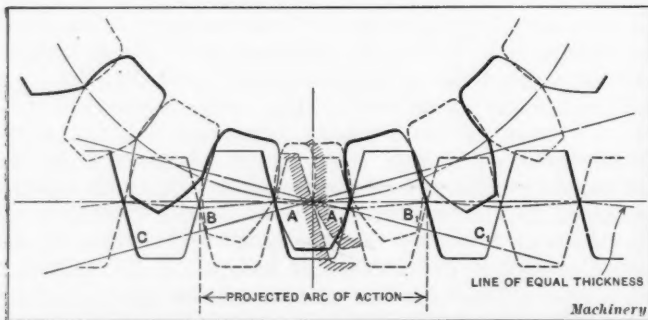


Fig. 2. Case I. Hob with Low Tooth and High Space centered. Full Lines show High Side and Dotted Lines show Low Side

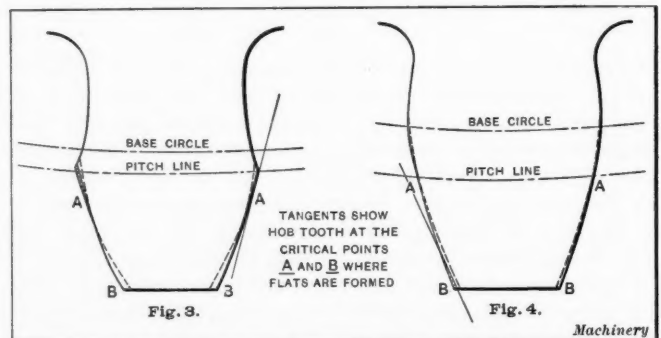
There are defects in the hob that no amount of centering will compensate for and insure symmetrical teeth being generated. Among these we may cite the defects due to distortion in hardening, unequal tooth thickness due to springing of the tool in forming, and errors in size resulting from careless workmanship. The defect that can be favored in the setting of the hob is that in which the eccentricity of the form and axis causes the teeth to run out. This eccentricity may be caused by the use of an inaccurate mandrel

in the backing-off operation or in not truing up the hob properly in grinding the hole; and may also be caused by an untrue hob arbor on the hobbing machine itself. These defects can be determined and proper allowance made to counteract the natural results by a careful setting of the hob. By knowing what result will be obtained with these eccentric hob conditions the defect can be diagnosed and a remedy applied or the setting can be made to favor the defective conditions.

Let us take the most common condition—the case where the axis of the form and that of rotation are eccentric and parallel—and treat it as follows: Case I. Hob with low tooth and high space centered. Case II. Hob with high tooth or low space centered. Case III. Hob not centered, but half way between the conditions of the two preceding cases.

### Case I for Fourteen and One-half Degree Teeth

The method of treatment is to take a normal gear and show it in mesh with the eccentric hob in the desired position: in this case, with the "high" space centered. This setting brings the tooth on the opposite side of the hob in the center if the number of gashes are even, and this opposite side is the "low" side of the hob. This is shown in Fig. 2. In each case, the high side is shown in full lines and the low or opposite side in dotted lines. The intermediate teeth which range from high to low are not shown except in the central



Figs. 3 and 4. Tooth Outlines showing how Flats are formed at the Pitch Line and at the Point in Case I

position in Figs. 2 and 5, and in the extreme positions in Fig. 8. An inspection of Fig. 2 will show that the pitch line of the hob, considered in its relation to the tooth itself, does not lie along a straight line parallel to the axis of the hob, but on a zigzag line that is shown broken. This line represents the pitch location of the right side of the hob tooth, and may be termed the "line of equal tooth thickness." It will have a drop for each pitch length of the hob for every convolution of the thread. In reality, the line instead of being zigzag should be a reverse curve.

In the central position indicated by the full lines, the contact between the teeth of the hob and gear is normal and correct. If the hob be given one-half revolution, the position taken is indicated by the dotted lines and it will be noticed that the gear and hob do not come into contact as they should at the points  $B$  and  $B_1$ , the space widening from the points of contact  $A$  and  $A_1$  to the points  $B$  and  $B_1$ . From this we may rightly assume that the hob would form the teeth of the gear with a fullness at the point, as indicated by the full line from  $A$  to  $B$  in Fig. 3. The dotted line shows the normal curve of the tooth. If the hob is given a quarter turn from the full line position, the relative position of the teeth of both the gear and hob is at the dotted line position shown in the center of Fig. 2, midway between the teeth instead of giving the normal contact at the pitch point on the pitch line of both gear and hob. This should develop a fullness of the gear tooth at the pitch line diminishing again to normal at the point  $A$ . But the normal position of the hob tooth at the point  $A$  brings the edge of the hob tooth inside of this bulge, so that it would remove the greater

\* For other articles on the subject of hobs and hobbing which have appeared in MACHINERY see "Special Hob Tooth Shapes," by John Edgar, published in May, 1914, and other articles there referred to.  
† Address: 61 Bruce Ave., Windsor, Ontario, Canada.

portion of it shown in cross-section in Fig. 3, leaving a flat from the point *A* extending to the pitch line. In exaggerated cases, in cutting large numbers of teeth, the flat will extend past the pitch line to the base of the involute.

When the projected arc of action shown in Fig. 2 is greater than twice the pitch of the teeth, which is the case when cutting gears with a greater number of teeth than 36, the trimming of the involute portion of the teeth takes place through two or more turns of the hob instead of one. This brings the tooth of the hob more nearly into the normal position at the end of the gear tooth, tending to make the point of the tooth nearer to the proper thickness; but the correct thickness is never reached as it would be necessary for the contact to continue to the position *C*, which is the case of a gear of infinite diameter. This develops a flat at the point of the tooth for the same reason as that given for the flat produced at the pitch line. The result of this action on gears with teeth greater in number than 36 is illustrated in Fig. 4, where the cross-sectioning shows the excess metal removed, resulting in the production of the flat. The effect on the flank of the tooth need not be taken into consideration; as the hob leaves it, there is ample clearance for the gear tooth of the mating gear, it being only in the case of a gear meshing with a rack that the flank would be apt to give trouble.

#### Case II for Fourteen and One-half Degree Teeth

The high tooth centered, as illustrated in Fig. 5, shows the normal contact between the teeth at the points *B* and *B*<sub>1</sub>. With the hob revolved one-half turn, the low space comes into the central position, but there is no contact between the teeth at the points *A* and *A*<sub>1</sub>. In the central position where the pitch lines of the gear and hob are tangent, instead of the normal contact we have a space between the teeth. *A*

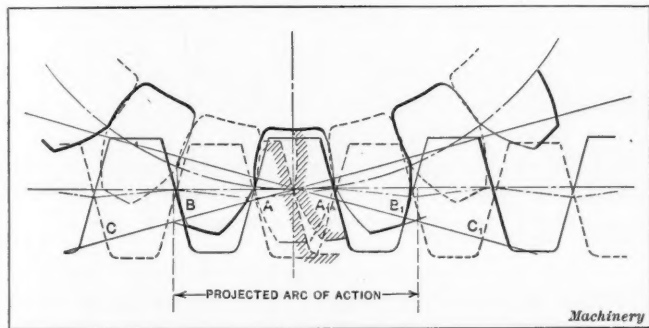


Fig. 5. Case II. Hob with High Tooth and Low Space centered. Full Lines show High Side and Dotted Lines show Low Side

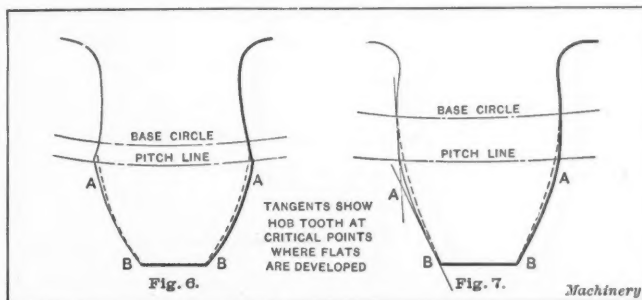
gear generated with the hob set in this position would have teeth of the form illustrated in Fig. 6, with fullness at the points *A* and a perceptible flat below the pitch line, which extends to the base circle in gears with a large number of teeth. In the case of gears with more than 36 teeth, the normal contact at the points *B* and *B*<sub>1</sub> develops into a space and results in a flat at the point of the teeth, as shown in Fig. 7.

The two preceding cases give the two extremes in setting the hob central and show the results of eccentricity of the axis of form and the axis of rotation. Of the two methods, the latter is the more practical. By centering the high tooth the depth is easily obtained, whereas in the first case with the high space centered, the depth is not so easily obtained because the centered tooth is the low tooth and if the hob is fed to depth after bringing it so as to mark the blank, the depth will be deeper than that shown in Fig. 2 and the tooth thickness will be under size. The reverse is the case with the second method of setting, but to obtain the proper tooth thickness the hob will have to be fed in deeper than the standard amount. The pointing of the tooth at *B* in Case II will give better running gears than the fullness at the point as in Case I.

#### Case III for a Fourteen and One-half Degree Tooth

By moving the hob along so that the pitch point lies on the edge of the high tooth, as in Fig. 8, we have a case which gives results similar to those obtained by setting the hob at random, and we will get results more or less unsymmetrical. The full lines in Fig. 8 show the high side of

the hob in normal contact with the gear teeth, with contacts at the pitch point and at the point *A*<sub>1</sub>. On bringing the hob into the opposite position with the low side, or to the location shown by dotted lines, we find no contact at the pitch point nor at point *A*. Rolling the gear until the teeth come to the end of the normal point of contact on the pressure line at *B* and *B*<sub>1</sub> on each side of the pitch point, we will find a space at *B*<sub>1</sub> instead of the contact as at *A*<sub>1</sub>, and a lessened space at *B*. Had this rolling brought the gear tooth to the low hob tooth position, as at *C*<sub>1</sub>, the space at *B*<sub>1</sub> would have been maximum and the position at *B* would come into con-



Figs. 6 and 7. Tooth Outlines showing Points at which Flats are produced in Case II

tact with the high tooth at *C*. Further rolling of the gear away from these positions would tend to reduce the space to the right and to develop a space to the left.

A hob in this condition and so set would generate a tooth with the left side normal at the pitch line, with a bulging face; and with the right side full at the pitch line and nearly normal at the point of the tooth, with a flat near the point when the hob is cutting to depth. The case of a twelve-tooth pinion is shown in Fig. 9; and the case of a larger gear in which the contact between the teeth of gear and hob continues to the point *C* of Fig. 8 is illustrated in Fig. 10. In both cases, the last "swipe" of the hob tooth will cover a broader length of the tooth than it ought to, and will leave a flat at the point on the left side of the tooth. Similarly, in the case of both Figs. 9 and 10, the hob tooth in the position *A*<sub>1</sub> of Fig. 8 will leave a flat at this point covering considerable of the right side of the tooth face. The cross-sectioned areas show portions of the bulges cut away, leaving flats.

The method outlined in Case III has the same effect as centering any of the teeth of the hob except the high or low tooth, so that the usual procedure of shifting the hob to bring new cutting points into position will result in unsymmetrical teeth being developed in the gear if the hob runs out of true with the axis of rotation. The actual amount of the distortion in the teeth generated will depend upon the amount of eccentricity of the hob form and is approximately one-fourth of the eccentricity on each side of the

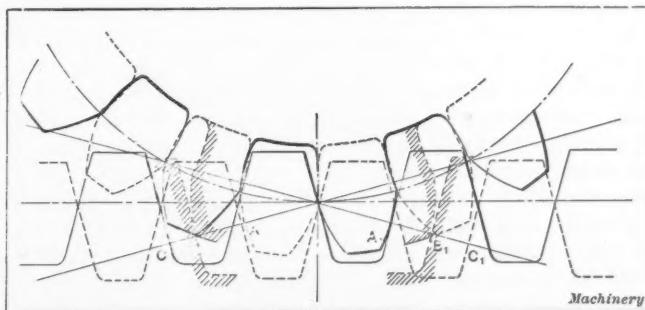
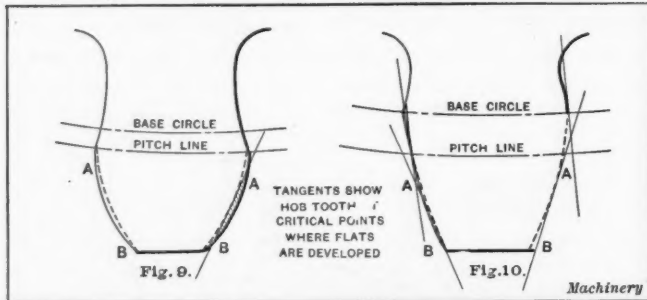


Fig. 8. Case III. Hob centered midway between Positions in Case I and Case II

tooth. In Fig. 3, for example, the amount that the tooth is thick at the point *B*, for a hob 0.002 inch eccentric, will be 0.0005 inch on each side or 0.001 inch altogether. The amount of the space at the pitch line would be the result of only one-half the eccentricity, as the tooth is in the mean position at this point.

Several cases could be treated in this way, as for instance, the case where the axis of form is not parallel with the axis of rotation but where these axes intersect. The only remedy that would make it possible to obtain symmetrical teeth

would be to find the point of intersection of the axes and set the hob central with that point. But instead of setting the high tooth central, as in Fig. 5, the hob should be set in such a position that the axis of the form lies in the same plane as the spindle on which the gear is placed, and the hob should be set central irrespective of the location of the teeth of the hob. That is, the hob should be set so that the point of intersection of the two axes will lie directly in line with the axis of the work spindle of the machine, whether or



Figs. 9 and 10. Tooth Outlines showing Flats produced by Hob set according to Conditions of Case III

not the tooth of the hob comes central. Of course if a tooth comes into this position, so much the better for the symmetry of the teeth of the gear. This setting is illustrated in Fig. 11. The unsymmetrical results sure to be developed by any other setting are quite obvious without further exposition.

The preceding treatment of three typical cases gives some light on the cause of the poor shape of the teeth so often complained of in the results obtained from the hobbing machine, and while this discussion does not include all of the defects that will produce similar results, it does emphasize the fact that more care will be necessary in the preparation of the hobs than has formerly been the practice. Eventually we shall have the ground hob, with the defects of hardening and careless forming eliminated by grinding the hardened hobs on precision machines in which the human element will be reduced to a minimum, so far as its effect on the accuracy of the hob is concerned. When such hobs are available, the hobbing process will meet with little or no opposition based on the unreliable results obtained by it. However, until the ground hob is perfected, flats and unsymmetrical tooth outlines will be a source of worry to the user of the hobbing machine and he will meet the results already pointed out in my article "Hobs for Spur and Spiral Gears," published in the July, 1912, number of *MACHINERY*. In that article, a remedy was given to reduce the effects of the careless workmanship, and a further means of correcting such defects and distortions of the hob teeth is outlined in the following paragraph.

This consists of the more direct process of grinding out the distortion of the teeth from the narrow helical path, and of bringing their cutting edges back into the proper helical relation with each other. All that is necessary for the operation is a toolpost grinder—preferably an electric machine. Of course it goes without saying that the more carefully the performance is carried on, the more satisfactory will be the results obtained.

The procedure is simply this: Set the lathe to the proper lead of the hob, with the toolpost grinder on the slide-rest, and with a clean cutting wheel grind the edge of the side of the teeth into the proper helical relation. It is necessary to be careful not to grind too much from the side of the teeth; just let the wheel touch the teeth all the way around, and if the mandrel on which the hob is held is running true, the hob thread will be straightened up. It will be noticed that the land left by the wheel is not uniform and the amount that the teeth are out of true is directly proportional to the width of this land. It will also be noticed that some rows of teeth will have wide lands while those of the opposite side of the hob will have narrow lands; this is the result of the eccentricity of the axis of form with the axis of rotation and should be corrected by grinding the teeth back until the lands are of uniform width. This is

the same treatment that was given for the correction of careless spacing and improper sharpening in the previous article referred to. Besides this regular variation in the width of the ground lands, other irregular lands will be noticed which are the result of singly distorted teeth, due to careless forming or to distortion in hardening. If the land left by the wheel is not so wide as to cause the teeth to drag on account of the relief being ground away, they may be allowed to remain in the condition as left by the wheel, or they may be treated singly by grinding back as in sharpening.

The results obtained by this treatment more than pay for the time and expense, and where a hob is giving trouble this remedy is recommended. A hob thus treated need not be centered, as the teeth generated by it will be symmetrical by the most rigid test usually applied to commercial work. The treatment will have to be repeated at each sharpening, however, to insure the continuance of the good results. In choosing the change gears for the lathe, the axial lead corresponding to the normal pitch of the teeth must be used; and as a difference of 0.0005 inch is noticeable in the angle of the teeth, the lead must be closely followed. Some such treatment as this is necessary with the irregular hobs now obtainable.

In conclusion, it may be well to apologize for the title. The answer is that with the unground hob in which the eccentricity is an unknown quantity, but may be taken as sure to be existent, it is well to center the high tooth as in Case II; and with the accurate hob, that will be available when the methods of grinding the teeth are perfected, it will be unnecessary to center the hob if the hob has been carefully sharpened and the hob arbor runs true on its axis. While the results revealed by the treatment of the three cases seem to be unfavorable to the hobbing process, it is such studies as these that bring the truth to light and lead the way to the remedy which, when applied, brings to the hobbing process the share of consideration it deserves as one of the simplest and most efficient methods for the production of the teeth of gears.

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Engineers, designers and others who have studied foundry practice, know that it is bad practice to make patterns with sharp corners. The sharp corner in a casting is the seat of weakness and possible failure. But notwithstanding this common knowledge, we go on committing the error every day. Prof. John E. Sweet has preached the gospel of liberal fillets

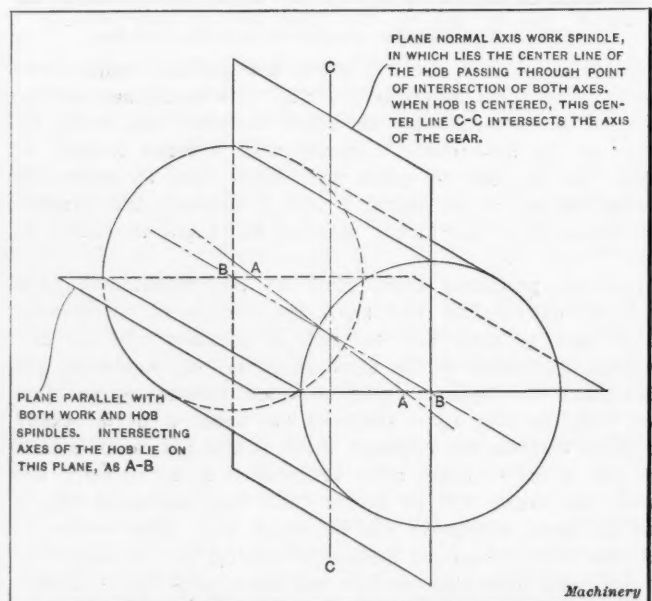


Fig. 11. Method of setting Hob when Axes of Form and Rotation intersect

and points out that in many places their use means an appreciable saving of iron. In the case of large cast-iron pipe tees, a fillet with a radius of three inches at the junction of the tee saves ten pounds of iron as compared with the not uncommon pattern having a very small fillet radius, and a better and lighter casting is the result.

## REPLACING PINS IN THE WILLIAMSBURG BRIDGE

AN EXCEPTIONAL BORING OPERATION PERFORMED UNDER UNUSUAL DIFFICULTIES

**T**HE structure of the Williamsburg Bridge, New York City, is at present being strengthened to sustain the increased load to which it is being subjected by additional traffic. This is done by building four additional towers under the approach spans between the main towers and the anchorages, and by strengthening the trusses. In

the ten-inch pin with the thirteen-inch size, this load was transferred to a new girder erected transversely above the ends of the main span trusses close to the tower. From this girder the approach spans were suspended, the load being transferred to them by means of wedges to relieve the pins. In order to rebore the pin holes from ten to thirteen inches



Fig. 1. Williamsburg Suspension Bridge across East River, New York City—Arrow indicates One Point where 10-inch Pin was replaced by a 13-inch Size, necessitating an Unusual Boring Operation

connection with this work it became necessary to replace four hinge pins which connect the approach span trusses with those of the main span just outside of the main towers on the land sides. The original hinge pins had a diameter of ten inches, whereas the new pins are thirteen inches in diameter. One of these pins is located at the point indicated by the arrow in Fig. 1, and the other pin for this tower occupies a corresponding position on the opposite side of the tower.

There are also corresponding pins for connecting the approach span to the tower on the other side of the river. These pins are about two feet below the level of the roadway and twenty inches from the tower leg. Fig. 2 shows the opening made through the floor of the south roadway preparatory to removing and replacing the pin on this side.

Heretofore, each of these pins was subjected to a load of 800,000 pounds from the approach span. In order to replace

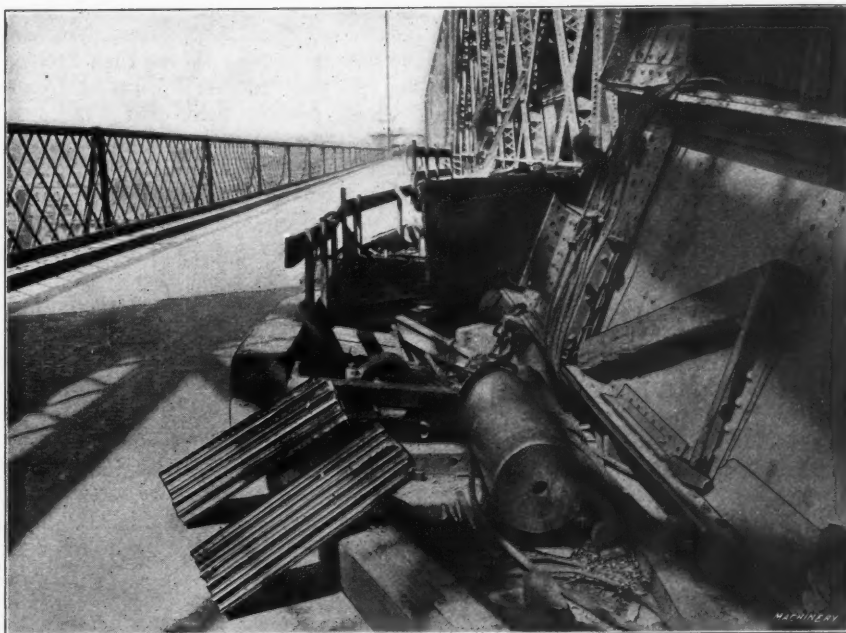


Fig. 2. Hole made in Roadway to make Room for Boring Machine—Collapsed 10-inch Pin and New 13-inch Pin in Foreground

diameter, placing the new pin in the hole and erecting the new wind member on this pin.

To obtain the necessary rigidity between the different members while boring, steel plates, tie-rods and special castings were fastened to the truss members and joined by bolts and wedges just before the boring operation was started. All traffic on the bridge but that of pedestrians, was stopped at 1 A. M., and the task of removing one of the pins, rebor-

ing in diameter, the truss members surrounding the hole had to be held perfectly rigid during the boring operation. This rigidity could not be obtained while the traffic on the bridge was in operation and even without the traffic the wind pressure and temperature stresses were likely to interfere with the boring; moreover, as the bridge is a main artery of traffic, only one night could be spared for the operations of removing one of the old ten-inch pins, enlarging the pin hole to thirteen inches in

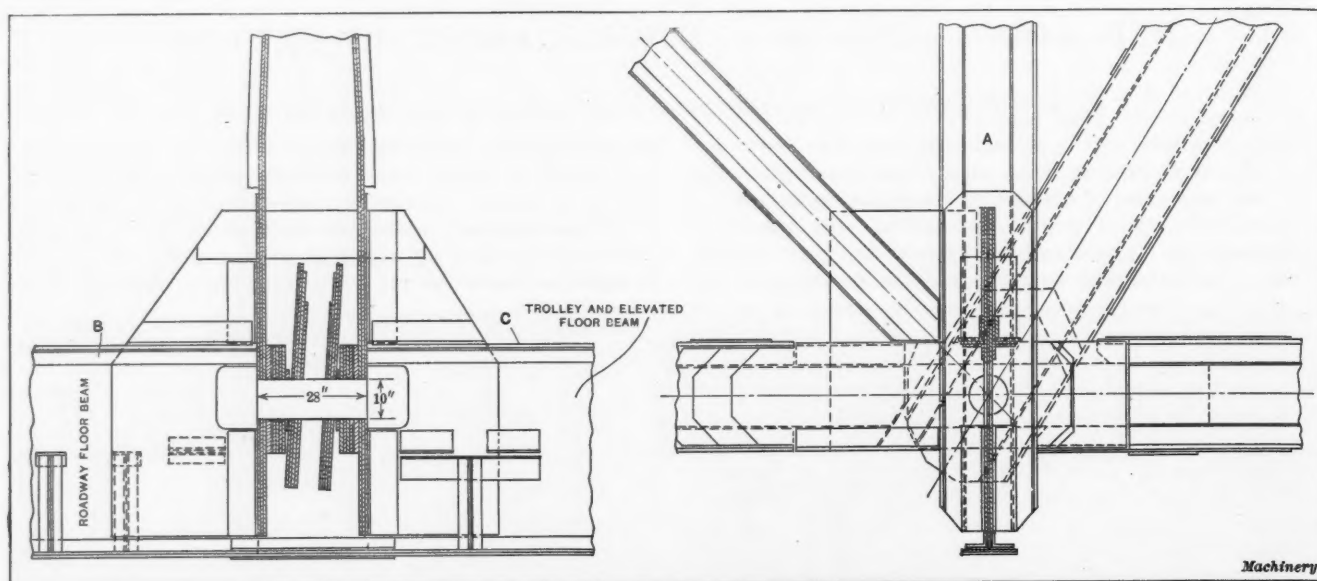


Fig. 3. Section and Elevation showing Pin Connection between Approach and Main Span Trusses

ing the hole and inserting the larger pin was begun. At 5:50 A. M. of the same day the new pin had been put into place and the bridge was open to traffic. It is evident that every step connected with this work had to be carefully planned beforehand. First, it was necessary to design and build a special machine for reboring the pin holes. The total length of the hole is twenty-eight inches, twenty-four inches of which is formed in solid steel plates. Some of these plates occupy oblique positions, as shown by the sectional view to

side, which supports the trolley car tracks, had to remain in place. After considering various ways of doing this work, a design of boring machine was finally adopted by the Department of Bridges; F. J. H. Kracke, commissioner; Alexander Johnson, chief engineer; Austin Lord Bowman, consulting engineer; and Leon S. Moisseiff, engineer of design. The structural design was in charge of Isidor Delson, assistant engineer; and J. R. Geogham, assistant engineer, was in charge of construction. The design of the machine and the boring operations were in charge of Martin Joachimson, assistant engineer.

It was found impossible to remove the old ten-inch pin, which was tightly stuck into its hole, even after the load had been transferred to the overhead transverse girder previously referred to. All attempts to remove this pin failed. An idea as to how tightly it was held in place may be obtained from the following: The pin had a  $1\frac{1}{2}$ -inch hole extending through its center and this was enlarged at the outside end to  $2\frac{1}{2}$  inches and tapped. A bolt was then entered into this hole and by tightening a nut against a resistance, with large wrenches, an attempt was made to pull the pin out. The result was that the bolt snapped across the body but the pin did not move. It was then decided to collapse the pin in the following manner: On a horizontal line each side of the  $1\frac{1}{2}$ -inch central hole, two  $1\frac{15}{16}$ -inch holes were drilled through the pin from end to end, which left six walls about  $\frac{1}{8}$  inch thick across the mid-section of the pin. As soon as a hole was drilled, tapered plugs were driven into both ends to prevent any distortion of the pin that might result from the stresses to which it was still subjected. After all the holes were drilled, the walls were removed one at a time, and, finally, after removing all of the plugs, the pin was collapsed and the two halves were pulled out easily.

In the operation of boring the  $1\frac{15}{16}$ -inch holes, the frame of the boring machine was used as a support for the smaller boring-bar. This bar, which is  $2\frac{1}{2}$  inches in diameter, was carried in two ordinary boxes or bearings as shown in Fig. 4, and was provided with an internal Morse taper at the end toward the pin. At the outer end there was an external



Fig. 4. Drilling Series of Axial Holes through Old 10-inch Pin to collapse it

the left, in Fig. 3, which further complicated the boring operation. The total amount of steel which had to be removed was 1300 cubic inches. The time limit for the boring operation was two hours.

The design of the boring machine was limited in several ways, but principally by the small space available between the axis of the pin hole and the leg of the main tower of the bridge, this distance being only about twenty inches in a horizontal direction. The problem was made more complex by the fact that the truss and roadway of the bridge connected thereto, are constantly moving either toward or away from the tower, which prohibited the use of the latter as a support for the boring machine. To the post A of the bridge (Fig. 3) which holds the pin, floor beams B and C are fastened on both sides at the vertical center line so that their webs cover the pin hole, as shown by the elevation at the right. While it was possible to remove a part of the floor beam on the roadway side of the post, the beam on the rear

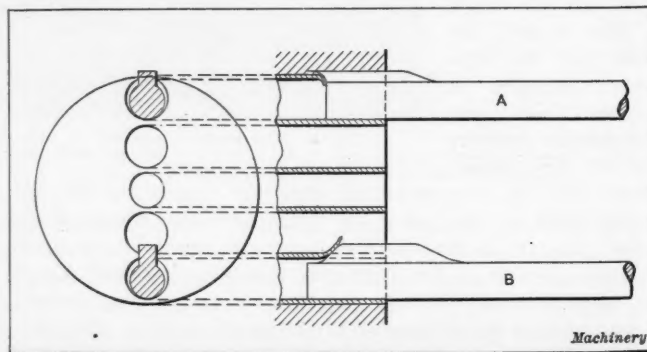


Fig. 5. Tools used to cut away Walls between Axial Holes drilled through Pin as illustrated in Fig. 4

taper where connection was made with a pneumatic drilling machine. After one hole had been bored, the bar was aligned for boring the next hole by placing packing blocks under the journals. The length of these holes was 29 inches and the drilling of each hole required three drills of different lengths, because of the limited space which made it impossible to use a longer boring-bar. These drills were of high-speed steel and had lengths of twelve inches, twenty inches, and thirty inches, respectively.

The walls between the holes were removed for collapsing the pin by means of special tools, as indicated by the diagram Fig. 5. Two types of tools were used, as indicated at

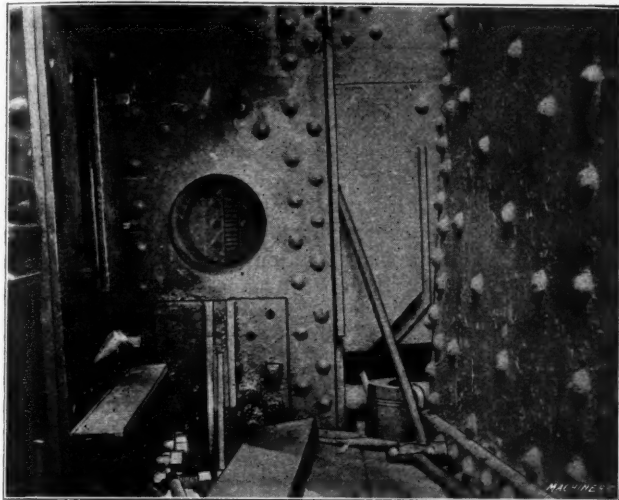


Fig. 6. Pin Hole after Removal of Pin and before re boring

A and B, and these were driven through the holes by means of a sledge-hammer. The slanted nose of tool B was used to cut away the walls between adjacent holes, whereas the walls at the outside of the pin were removed by the tool shown at A, which was provided with a cutting edge at the front, as the illustration shows. It required only about fifteen minutes to drive out one of these walls, where the minimum thickness was  $\frac{1}{8}$  inch, but a considerably longer time was necessary where the wall was thicker. The drilling of one of these 115/16-inch holes through twenty-nine inches of steel required about five hours, but the holes were drilled so accurately that not one of the walls was pierced when drilling the adjacent hole.

The two halves of the severed ten-inch pin are shown in Fig. 2, and also the new thirteen-inch pin at the right. The

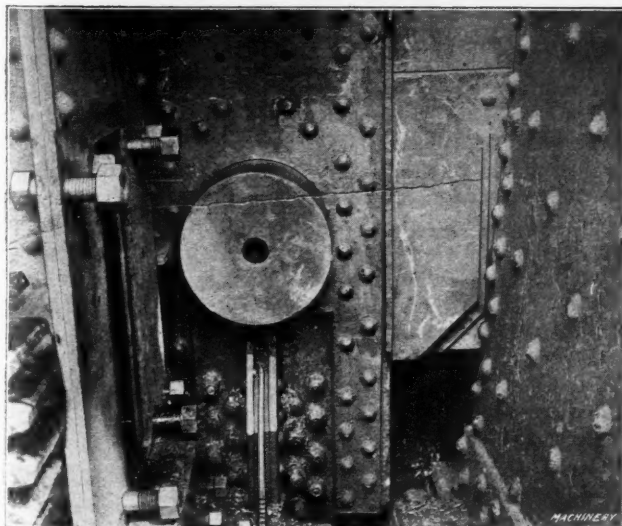


Fig. 7. View showing New 13-inch Pin in Position

ten-inch hole, after the pin was removed, is shown in Fig. 6; whereas, Fig. 7 is a view taken after the hole was bored and the new thirteen-inch pin was inserted. The special boring machine and tools used will be described in a later article.

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The British Navy Department has announced that it has abandoned its own fine screw thread system in favor of the British standard fine screw threads.

## ELECTRIC MOTOR STANDARDIZATION\*

WHAT FEATURES OF ELECTRIC MOTORS CAN BE STANDARDIZED FOR MACHINE TOOLS

BY CHARLES FAIR†

This paper is not written so much with the idea of actually settling at this time the question of standardization of motor dimensions and speeds for machine tools as it is with the idea of pointing out a method which if followed should accomplish much toward the standardization desired. Certain of the dimensions and speeds once standardized will result beneficially not only to the machine manufacturer but to the motor manufacturer and to the machine user as well.

### FACTORS TO BE CONSIDERED IN STANDARDIZING MOTORS FOR MACHINE TOOLS

SPEEDS				
Constant Variable <sup>3</sup>	A. C. { Full load / Synchronous	{ Cycles / Phase / Voltage	{ Squirrel cage / Slip ring <sup>4</sup> / Internal resistance	{ High torque / Normal torque
	D. C. { Full load / Light load	{ Voltage	{ Shunt / Compound <sup>3</sup> / Series <sup>3</sup>	
Adj'tble Variable <sup>3</sup>	D. C. { Voltage		{ Shunt / Compound <sup>3</sup> / Series <sup>3</sup>	
	A. C. {	Brush Shifting		{ Shunt characteristics / Series characteristics
		Multi-speed <sup>5</sup>		{ Constant horsepower / Constant torque
		Slip ring <sup>4</sup>		{ Multi-speed <sup>4,5</sup>
NOTE				
1. Adjustable speed motors.—Infinite number of fixed speeds within their speed range.				
2. Variable speed motors—speed varies with the load { series / compound / slip ring				
3. Compound wound motor—speed varies with the load and proportion of series and shunt winding.				
4. Slip ring motor.—If resistance is left in circuit, speed varies with load and resistance.				
5. Multi-speed motors.—A limited number of fixed speeds, seldom more than four as 600, 900, 1200, 1800.				
SHAFTS				
Diameter / Keyway / Length / Special extensions / Double extensions	{ Gear	{ Involute / Herringbone	{ Steel / Rawhide	
		{ Bevel, worm	{ Thrust	
	{ Chain / Coupling / Belt			
		{ Auxiliary drive / Handwheel		
FRAME				
Bottom of feet to center line of shaft				
Shoulder on shaft to center of feet				
Overall dimensions of feet				
Drilling of feet—dimensions and sizes of holes				
DRIVE				
Gears	{ Peripheral speed	{ Normal for constant	{ Cost / Size	
		{ Maximum for adjustable		
{ Minimum number of teeth, pitch, face bore				
Chain, coupling, belt				
Reversing, non-reversing, slow-down, brake			{ Dynamic / Solenoid / Mechanical	
Range of speed required		{ Cost / Size of motor	{ Diameter vs. Length	
{ All geared drive for constant speed		{ A. C. / D. C.		
Balance of rotating parts				
Change gears—motor speed overlapping				
GENERAL				
Uniformity marking motor terminals				
Uniformity control diagram				
Protection of live parts				
Covers for end shields, etc.				

The importance of motor driven tools has now reached such proportions as to warrant most serious consideration of this subject.

There will, of course, always be demands for odd combinations of speeds and requirements and these it would be useless to attempt to standardize; but by far the majority of cases could be standardized under a heading that for con-

\* Paper read at the National Machine Tool Builders Association convention, held in Worcester, Mass., April 23-24, 1914.

† Power and Mining Department, General Electric Co., Schenectady, N. Y.

venience might be known as normal, and our efforts should be bent toward standardizing these speeds and dimensions.

For years and under generally adverse circumstances, much progress has been made in the standardizing of certain machine parts, with results advantageous both to the machine manufacturer and to the machine user. For a long time it has been recognized as desirable at least on the part of a number of the machine tool builders that something be done toward standardizing certain motor dimensions, speeds, etc., for machine tool drive. For the past five or six years attempts have been made to standardize certain dimensions and speeds for machine tool motors, but these attempts have failed for various reasons. It would be of little use to analyze these past failures. Unquestionably there should be first of all a better understanding on the part of the machine manufacturer and the motor manufacturer of each others difficulties; and much work is essential before material progress along the line of standardization can be accomplished. With this in mind, I have prepared an outline which I think fairly presents the situation from the viewpoint of both sides and which must be considered if real progress or results are to be obtained.

It could not be expected that the electrical manufacturers would change existing standards of motor dimensions or speeds, nor do I believe it would be either desirable or practicable to do so on account of the confusion that would result; but I see no reason, if the machine manufacturer in conjunction with the motor manufacturer will give the subject the consideration it warrants, and do his part toward bringing about a better understanding of what is really desirable in the way of speeds and dimensions, why the motor manufacturer, in turn, cannot incorporate, at least in part, some of the dimensions and the speeds when bringing out new lines of motors. Obviously it would be just as impracticable for the various motor manufacturers to design their motors to a single set of dimensions as it would be for the machine manufacturers to design their machines to a single set of dimensions. Notwithstanding this, however, much can be done to improve the situation. The American Society of Mechanical Engineers has offered to cooperate and is willing to do everything within its power to help in this question of standardization. Before going further into the subject, it might be well to look at the outline given in the accompanying table that we may have a better understanding of the subject as a whole.

For the sake of convenience, I have divided the outline into five parts, namely, speeds, shafts, frame, method of drive, and general.

**Speeds.**—Under the heading of speeds, there is an almost endless number of constant, adjustable, and variable speed combinations available, but from this great variety, certain speeds should become the logical ones for the majority of drives. The direct current constant speed shunt motor speed, for instance, should logically be that of the alternating current sixty-cycle motor. Alternating current and direct current motor speed should be given in terms of full load or else in terms of both no load and full load. It is, of course, understood that the cycles fix the alternating current speeds, except as modified by slip, etc. Adjustable speed motors would naturally be higher in speed on the highest speed than a constant speed motor because the adjustable speed motor would only run a certain percentage of the time at high speed. Adjustable speed motors are nearly always geared and their speeds should be governed by a proper gear speed.

There should be little difficulty in arriving at a set of suitable speeds per horsepower to be known as standards for both constant and adjustable speed motors after properly considering the items as set forth in the table.

**Shafts.**—Obviously there should be little difficulty in arriving at a proper shaft diameter and key for a given horsepower and speed motor. The length of shaft might offer some difficulty, but a compromise length could probably be agreed upon. Special shaft extensions and double shaft extensions, whether for handwheel or power transmission, should be considered.

**Frame.**—A uniformity of dimensions under this heading is

obviously impossible but much can be done to reduce the large variety of dimensions to perhaps two or three sets per frame instead of the dozen now existing. There is, of course, no reason why there should not be a uniformity in the size of the holes drilled in the motor feet per frame.

**Drive.**—It is not only important but absolutely necessary to consider seriously the items under this head in order to arrive at some basis upon which properly to determine the best speeds, shaft dimensions, etc., to standardize. Here we should consider such subjects as diameter of motor *versus* length, minimum speed *versus* size and cost, maximum variation for adjustable speed motor and its relation to minimum speed, cost, and size of motor.

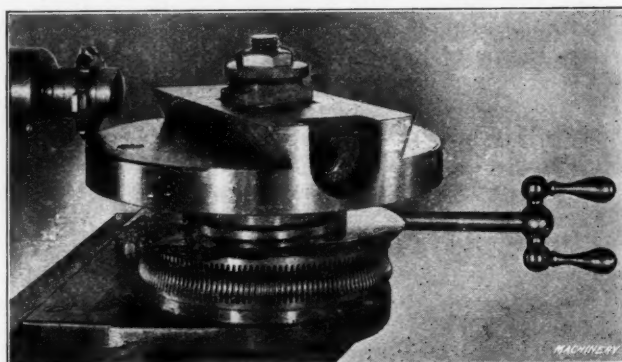
**General.**—Uniformity of making motor terminals, wiring diagrams, protecting live parts, etc., is of advantage to all concerned.

The machine user will derive considerable advantage from the standardization of motor speeds and dimensions as well as the machine manufacturer. The importance of the motor-driven machine tool with relation to production has become such that the method of applying the motor to the tool, in my opinion, warrants far more attention than has been given to it in the past by some of the tool manufacturers.

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## EDGE-ROUNDING ON A MILLING MACHINE

The simplest jobs are often the most troublesome. The Stockbridge Machine Co. of Worcester, Mass., had one of these simple jobs that caused considerable trouble for some time. It was the rounding off of sections of the edges of swivel-plates used in the heads of their shapers. The edge of the plate required rounding over for a section of about ninety degrees on each side of the swivel-plate. To round the edge over with a file, giving the same appearance to each side of the plate and stopping off at points uniformly distant from the center line, was a job that was not always correctly done. To secure uniformity on this job, the superintendent of the



Rounding the Edges of a Circular Plate

shop of the above company devised the little rig shown in the accompanying illustration. This consists of a worm-wheel mounted upon a vertical arbor, which was mounted on a milling machine at right angles to the spindle. The swivel-plate is placed above the worm-wheel, and is capable of being rotated by means of a worm turned by hand. On the spindle of the milling machine there is a quarter-round forming cutter, and by turning the work on the spindle by means of the worm and worm-wheel the edge is uniformly rounded. Lines are marked for the beginning and end of each cut so that the rounding may be started and stopped at the right places. In addition to doing the work better, it is also a much quicker method.

C. L. L.

\* \* \*

In Holland, a special branch of engineering is devoted to land reclamation, that is, reclaiming the land from the sea and protecting it by dikes. The people of Holland boast somewhat irreverently that God made the rest of the world but the Dutch made Holland. From twenty to twenty-five thousand acres of land are thus "made" every year, but there are still 250,000 acres of the best land under water, susceptible to reclamation, not including the great area under the Zuider Zee, the reclamation of which is a never-ending topic of discussion. The question is simply one of engineering and the necessary capital to carry it out.

## MECHANICAL PRODUCTION RECORDING

AN ELECTRICALLY-OPERATED MECHANISM FOR INDICATING AND RECORDING MACHINE OPERATIONS

BY DOUGLAS T. HAMILTON\*

OF the twelve principles of efficiency classified and arranged by Harrington Emerson, the sixth, *viz.*, reliable, immediate and adequate records, is an important factor of efficient production. Information or data which has been secured from biased sources is worthless. Records which are not classified or arranged in such a manner that they can be referred to readily have little or no practical value, and records which are incomplete or inadequate are a hindrance rather than a help.

As an example, a piece-rate price which is set by stopwatch observations is not always accurate because of the human element, which complicates the problem. Records, to be reliable, must be made over a considerable period of time so as to cover all the variable conditions of material, operators, etc. Furthermore, the human element should be eliminated as far as possible and mechanical means substituted.

The electrically operated instrument to be described in the following gives this desired result. It operates, of course, independently of the operator and records accurately any movement of the machine to which it is connected. It is made by Slocum, Avram & Slocum, Inc., engineers, 30 Church St., New York City.

## Operating Mechanism and Connections

The mechanism of the "Productograph" consists primarily of magnets, which, when energized, attract needles that draw lines on a revolving chart. At the same time, the magnets actuate counters which record the number of lines drawn by the needles. Every tenth line on the chart is shown by a line a little longer than the rest, which greatly facilitates counting if the production of the machine between any two limits is desired. The needle point is made of German silver, and the chart of lead paper. The line drawn is very distinct and cannot be easily erased. No ink or other recording devices usually incorporated in instruments of this kind are necessary.

\* Associate Editor of MACHINERY.

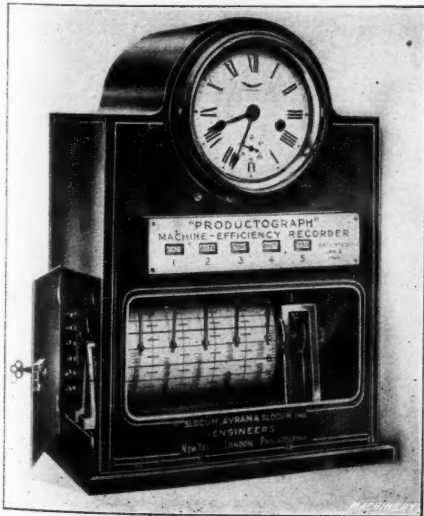


Fig. 2. The "Productograph"—a Machinery Efficiency Recorder

The movements of the machine under test are transmitted to the recording instrument of the "Productograph" by means of the switch shown in Fig. 3, which is attached to that portion of the machine on which a record is to be made. It consists of a small cast-iron box 3 by 4 by 1 1/4 inch, which is fastened close to any revolving shaft or part of which the motion is to be

taken. Inside this iron case is a ratchet *A* which is held on the arm *B* and carries a cam *C* usually worked out in a ratio of 10 to 1 with the ratchet *A*, but it can be made, of course, to suit any desired speed. By a 10 to 1 reduction between the cam and the ratchet, it requires ten oscillations of the switch arm *B* to make one contact; hence one line is drawn on the chart every ten oscillations of the switch arm. Cam *C*, through a lever *D*, operates a plunger *E* in an air chamber which, in turn, causes the contact of two flat springs *F*. The cam then allows the plunger to return immediately to its original position, so that no matter in what position the machine is left at night there is no danger of the switch being short-circuited.

The connections from the switches to the instrument are made by ordinary wiring, and from each of the switches fixed to the machine a single wire is run to the corresponding terminal of the magnet coil in the "Productograph"; in addition, a wire which is common to all switches is connected to the source of electric supply and thence to the common terminal in the instrument. The wire used should in no case be less than No. 16 B. & S. wire gage, but the size depends largely on the distance of the switches from the "Productograph." The conductor should be well insulated and carried in cleats and when running under or near the machine should be enclosed in circular loops. The neatest installation that could be adopted, of course, would be to enclose all wires in metal tubing.

Power for operating the "Productograph" is of three different types. Dry batteries should not be used because they become exhausted too quickly. Storage batteries may be used with good results if properly attended to, but the best and most satisfactory method is the motor generator. This can be connected to an ordinary lamp socket, and is the best means of obtaining regularity of movement of the drum and the correct action of the recording needles. This, of course, is absolutely essential if a complete and accurate record of any machine movements is to be obtained.

Samples of "Productograph" Records made on Bullard "New Era" Vertical Turret Lathes

A five-point "Productograph" installed in the plant of the Bullard Machine Tool Co., Bridgeport, Conn., was attached to one of their "New Era" vertical turret lathes. Five movements of this machine were connected to the "Productograph," *viz.*,



Fig. 3. Operating Mechanism of the Switch

the main head vertical feed, main head horizontal feed, table rotation, side head vertical feed and side head horizontal feed. By this means it is possible to make a comparison of the relative movements of the two heads—vertical and horizontal—in either direction and also to record the number of revolutions of the work table. Records have been made with the machine in operation on both steel and cast iron. The following gives the record that was made on a 0.40 to 0.50 per cent carbon machine steel forging.

**Efficiency Record of Bullard "New Era" Vertical Turret Lathe on 0.40 to 0.50 Per Cent Carbon Machine Steel Forgings**

The section of a "Productograph" chart shown in Fig. 5 shows a record of a Bullard vertical turret lathe on a run of



Fig. 4. "Productograph" recording Five Movements of a Bullard "New Era" Vertical Turret Lathe set up and in Operation on Large Cast-iron Flywheels

two hours, approximately. This is part of a time study which covered a period of ten days and which was made while machining eighteen unannealed 0.40 to 0.50 per cent carbon steel forged disks, 24 inches in diameter, each weighing 405 pounds in the rough. The instrument was attached to five different motions of the vertical turret lathe, giving complete and detailed records of every operation. The first column of this chart gives the main head vertical feed; the second column, the main head horizontal feed; the third column, the work-table speed, or revolutions per minute; the

fourth column, the side head vertical feed; and the fifth column, the side head horizontal feed. These various movements, except the table rotation, are recorded in thousandths of an inch.

The section of the chart in Fig. 5 shows when the tools held in either head are cutting, when they are being used at the same time, the rate of feed, the cutting speed of the work and the lost time between cuts—in fact, every detail that usually requires an elaborate and expensive stop-watch test. This record also shows the use of the rapid traverse movements by the operator. The actual running time of the work chuck for the test made on March 4 is figured out as 276 minutes, and the actual running time of the tools, 230 minutes, giving a productive efficiency of the machine of 83 per cent. The time from 7 to 10 A. M. was spent waiting for tools and the machine was run from 10 to 5:30 P. M., or approximately 390 minutes. The productive machine time, therefore, is 230 minutes and the combined machine and operator efficiency figured out on this basis is 60 per cent. These records were taken during a time study period before the best tool set-up had been determined and do not show the high efficiency ultimately obtained. Only a section of this "Productograph" chart has been shown in the illustration, but it demonstrates how this instrument records every desired movement of the machine, and gives an excellent comparison of the relation of the various operations and machine movements.

The chips removed by this machine were at times 1¼ inch wide by 0.018 inch thick and the material was full of hard spots. Fig. 8 shows one of the interesting arrangements used for machining this machine steel forged disk. The flange joining the rim and hub had to be machined tapering, and to provide for this a guide strip was held in a toolpost in the main head which remained stationary. The side head was used for taking the cut, the saddle being unlocked and kept in action, while the tool was traversed horizontally by the feeding mechanism. The data for the particular set-up shown in Fig. 8 is as follows:

Operations	Start	Finish	Average
Feed of work in feet per minute starting at smallest diameter of disk .....	71	205	138
Feed of tool in inches.....	0.011	0.011	0.011
Depth of cut in inches.....	1	1¼	1 1/8
Pounds of stock removed per minute .....	2.7	9.8	6.25
Revolutions of work chuck per minute .....	39	39	39
Length of cut in inches.....	..	..	6½

Material—0.40 to 0.50 per cent carbon machine steel forging.

The weight of the solid blanks in pounds was 405; the weight of the blank roughed out by the first operation, 185 pounds; the weight of the stock removed, 220 pounds; the total roughing time on both sides of the forging, 88 minutes; and the weight of the stock removed per minute, 2½ pounds.

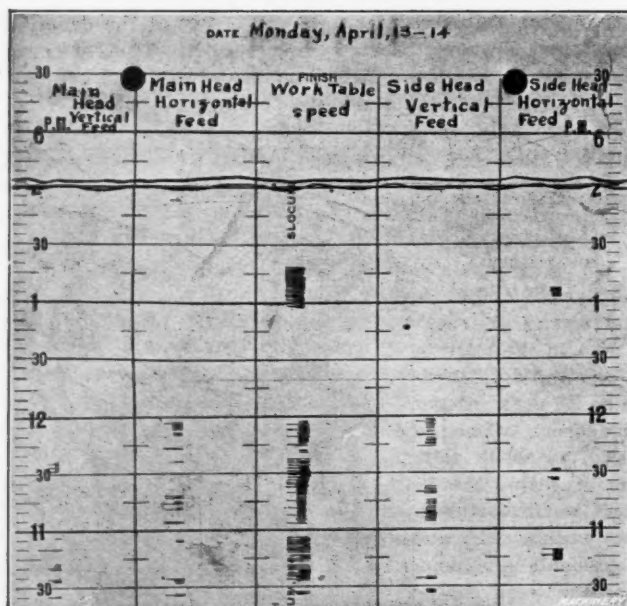


Fig. 5. "Productograph" Record of the Machining Operations of a Bullard Vertical Turret Lathe on a 0.40 to 0.50 per cent Carbon Steel Disk

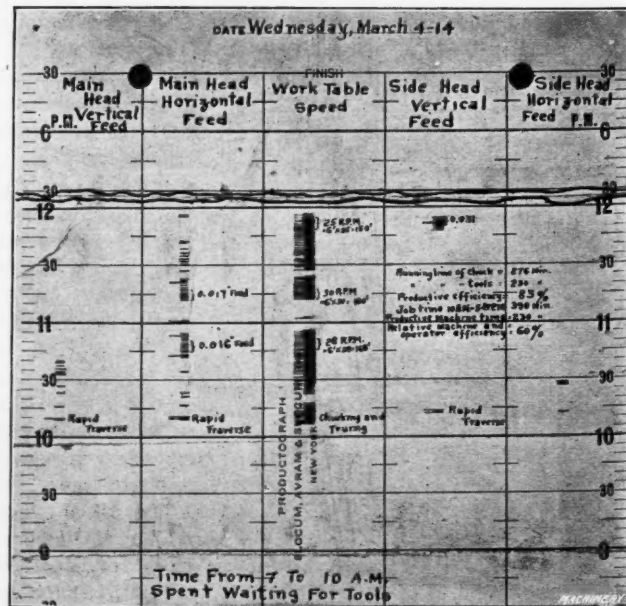


Fig. 6. "Productograph" Record of Machining Operations of a Bullard Vertical Turret Lathe set up and in Operation on a Large Cast-iron Flywheel

A "Productograph" Record made on a Bullard Vertical Turret Lathe—Machining a Cast-Iron Flywheel

Another job upon which a "Productograph" record was made in the plant of the Bullard Machine Tool Co. was a large cast-iron flywheel upon which five separate readings were made. For instance, the "Productograph" was connected by switches to the vertical shaft, rotating at an exact multiple of the table speed, to the cross-feed screw of the main head, to the down-feed screw of the main head, to the horizontal feed of the side head, and to the down feed of the side head. In this way, it was possible to secure relative

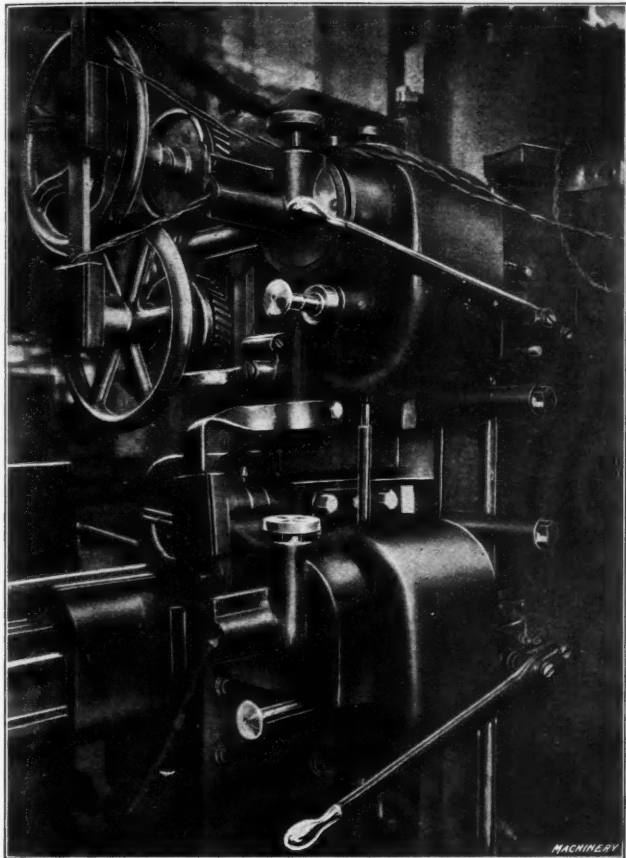


Fig. 7. The Movements of the Machine are transmitted electrically by Switches which are attached to the Operating Members

positions on the chart of these two heads and the time required for them to perform their individual operations.

On this job, a stop-watch test was also made to show how close the "Productograph" record was to the actual stop-watch test. The test started at 11 A. M. and was conducted as follows: Put wheel on table, 11:04; true up casting, 11:05; crown face with side head vertical feed of 0.131 inch per revolution,  $\frac{3}{4}$  inch depth of cut and a table speed of five revolutions per minute, a forming attachment as shown in Fig. 9 being used. This enables the rough-turning and crowning operations to be accomplished without reversing the position of the work on the table. 11:07, face side of rim with main head, using a cross-feed of 0.083 inch per revolution of the work, and a cut  $\frac{1}{2}$  inch deep; 11:15, main head cut finished; 11:16, side head cut finished; 11:16, finish-face side of rim with main head—hand feed to just remove the sharp corners; 11:17 $\frac{1}{2}$ , set up for finish-crowning rim, five revolutions; 11:18, finish-crown rim at 0.245 inch feed per revolution; 11:19, set for boring hole with main head, feed 0.083 inch per revolution of the work; 11:22 $\frac{1}{2}$ , final cut of side head finished.

Continuing operations, bring side head for facing hub into position; 11:23, face hub, 16 revolutions of work at a feed of 0.083 inch per revolution and a depth of cut of  $\frac{1}{2}$  inch—horizontal feed used; 11:26, change speed to 20 revolutions per minute; 11:27, side head cut finished—stop to clear chips from beneath hub of work to allow boring tool to enter to the correct depth; 11:27 $\frac{1}{2}$ , continue boring at a feed of 0.083 inch per revolution, 29 revolutions of the work required; 11:28, change cutter in the boring tool; 11:28 $\frac{1}{2}$ , start second boring cut and finish-face hub with side head at

a horizontal feed of 0.245 inch per revolution of the work; 11:30, finish-bore at 0.245 inch feed, rotating work at 48 revolutions per minute; 11:32, chamfer the hole with boring tool; 11:32 $\frac{1}{2}$ , ream hole 0.245 inch feed per revolution, work rotating at 39 revolutions per minute; 11:34, change cutters; 11:35, size hole with work rotating at 39 revolutions per minute and a down feed to the cutter head of 0.245 inch per revolution; 11:36 $\frac{1}{2}$ , chamfer hub with main head, 12 revolutions of work required using hand feed; 11:37, chamfer rim with main head—five revolutions required; 11:38 $\frac{1}{2}$ , take casting off machine; 11:40, casting off.

This casting, as tested with a scleroscope, indicated from 28 to 29 points hard. The weight of the casting before machining was 859 pounds, and after the first operation only, it weighed 722 pounds, indicating that 137 pounds of material had been removed in 40 minutes—the time required to complete the first operation.

Reference to the "Productograph" chart shown in Fig. 6 in comparison with the stop-watch test given will show that the instrument recorded not only the combination movements of the two heads, but also the revolutions of the work, indicating when the rapid power traverse was used; when analyzed it would also give the feed at which the cutting tools were operated.

The analysis of this chart, however, is not a simple matter and requires some study. The ratio of the gearing in the switches has to be taken into consideration and also any other ratios in the machine between the points where the switch is attached and where the movement that it is desired to record takes place. For instance, the vertical shaft on the Bullard vertical turret lathe does not rotate at the same speed as the table, but at an exact multiple of the table speed, so this ratio must be taken into consideration when figuring out the chart. However, as this information is all known beforehand it is simply a matter of using it as a constant when making the desired calculations.

Possibilities of the "Productograph" as an Efficiency Recorder

There are several different uses for the "Productograph" in the machine building plant or other manufacturing establishments. One very good application would be for setting piece-work rates. A test record can be taken over a long period of time so as to get both the machine and operator working at what might be called an average efficiency, which, of course, would be the only reasonable basis upon which to set a piece-rate. This record is made unconsciously by the operator so

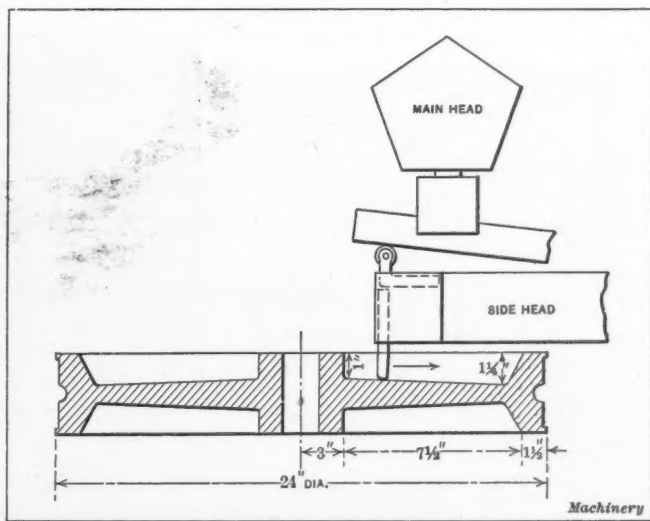


Fig. 8. Set-up on a Bullard Vertical Turret Lathe for machining a Beveled Surface on a Machine Steel Disk. For "Productograph" Record, see Fig. 5

that every move is recorded and the human element does not enter into the record at all; the result is, therefore, reliable.

From observations of this instrument on the Bullard vertical turret lathe, the following general conclusions are drawn: As a means of indicating the feed of the tools, the "Productograph" is of little value. Its application to the vertical turret lathe is satisfactory only in so far as it indicates the production in a certain specified time and the time required to turn

out each piece, also the production per day. This indicates the grade of the material, that is, whether it is hard or soft, and also whether the operator keeps the machine working to its best efficiency. By connecting various points of the "Productograph" with the different heads of the machine and its mechanical movements, it is also possible to trace whether the operator has followed the proposed layout or not. This is generally a vital point in the operation of a Bullard vertical turret lathe. There are certain combinations of tools in the main and side heads that give the best results for dif-

has broken down receives immediate attention. This tends to increase the value of factory discipline and increases production and efficiency.

Of course, any mechanical instrument of this kind will not raise the production of a plant, but it forms the basis upon which scientific methods of management can be properly conducted. It shows clearly what part of the investment is idle and what part non-productive, and in reviewing the charts from day to day the average efficiency of machines and operators can easily be obtained. It also shows up many other points as regards efficiency of foremen, operators, machines, etc., which it would be impossible to obtain without its use. While in a sense it is a detector of production as much as a recorder, it discloses defects and hence, instead of being a hindrance to an operator, it is really a help. The information is taken from the "Productograph" charts and entered upon daily and monthly cards, from which a comparison of the efficiency of the various machines in the shop can be easily obtained. If these records are properly kept up, they form a basis also for piece-rate working systems and other efficiency standards, as well as exact cost systems.

\* \* \*

It is probable that the first attempt to transmit power through any distance was by means of a rope. The first application of rope for power transmission was for hoisting and this suggested the possibility of using the

same method for transmitting power from one revolving shaft to another. A single rope was originally used which was essentially a sort of round belt running in a grooved sheave. The next development consisted of the application of a flat leather belt running on cylindrical pulleys, where a greater frictional surface was required for transmitting larger amounts of power. In modern practice rope drives are used to transmit high powers by the application of a number of strands of rope. The drive may either be arranged on the English system, where the required number of separate ropes are

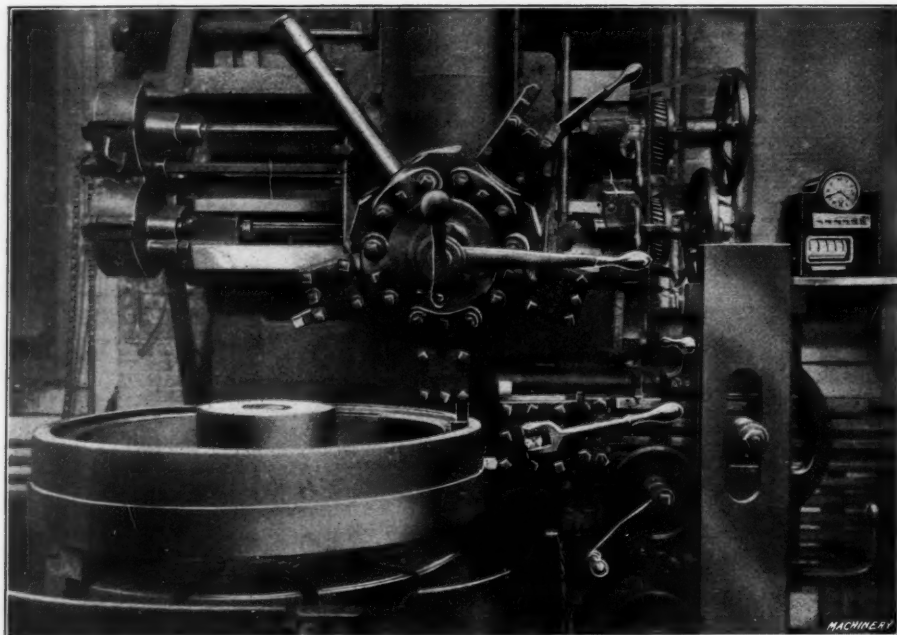


Fig. 9. Facing and Turning Operations taking place simultaneously. The Chart, Fig. 6, shows that this has been recorded

ferent jobs and this information is, as a rule, definitely obtained before the operator is set to work on the job. If he does not follow the outline suggested, he, in many cases, drops down below the estimate production. Of course, in the nature of things, he will not condemn himself and it is therefore impossible for the foreman to determine the reason for the decrease in production. The "Productograph" shows this up forcibly. It would seem that this point alone would warrant its installation in plants where large numbers of parts are to be turned out per day or year, on machines of the type where a certain specified order of operations has to be followed.

Probably the most important field of the "Productograph" is for machines which are set up and in operation on one piece of work and are run on that continually, and where the production from the machines per day is the only point on which a record is to be kept. The chart gives the information that the manager of a plant desires, and as it comes from an unprejudiced source it is of unquestionable value. Furthermore, it shows this record in such a manner that a manager can immediately find out whether a machine is working efficiently or not. For instance, as soon as a machine breaks down, the "Productograph" stops recording. A "live" manager will then call up the foreman to find out first hand what is the matter and just why the machine is not working. Suppose ten minutes or more after, the machine is still inoperative, the manager again calls up the foreman. This has the effect of making the foreman feel the responsibility of his position, and he thereafter makes it a point to see that a machine which

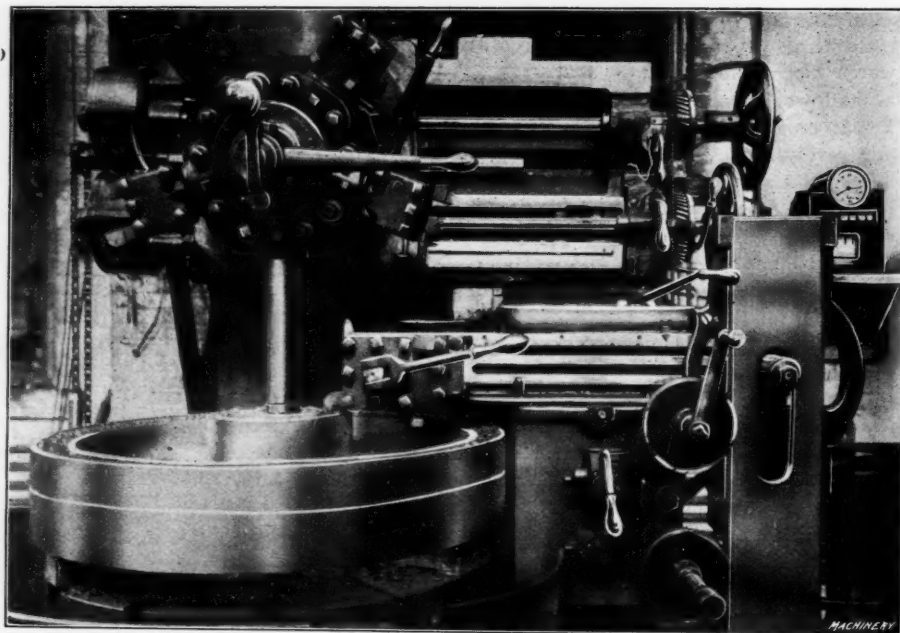


Fig. 10. A Difficult Facing Operation on the Bullard "New Era" Vertical Turret Lathe. Both Heads again are working simultaneously

used; or on the American system, where a single endless rope is employed, which is carried back and forth over the pulleys to provide the required amount of driving contact.

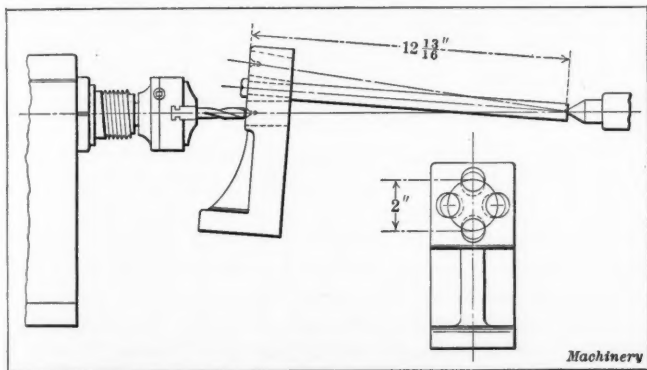
# LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

## A DIFFICULT DRILLING OPERATION

A rather novel way of accomplishing a difficult operation is shown in the accompanying illustration. The work consists of a bracket, in which it was required to drill four holes equally spaced around the circumference of a 2-inch circle; the holes had to be inclined at such an angle that their center lines would come together at a point 12 13/16 inches from the front face of the bracket. This job was handled very satisfactorily by first drilling a hole at the center of the circle around which the four small holes were to be drilled; the center hole was square with the face of the bracket and was for the purpose of receiving a stud 12 7/8 inches in length. The stud was centered at the further end to receive the tail center of the lathe, thus locating the face of the bracket 12 13/16 inches from the tail center.

The four small holes to be drilled around the circumference of the 2-inch circle were now laid out and center-punched, after which the work was ready for the drilling operation. The stud was located against the tail center of the lathe and the holes centered to 5/16 inch with a combination center drill. When the holes had been drilled and reamed the bracket was taken off the stud and mounted on a plug in a draw-in chuck, then counterbored a short distance to the size of the drill that was to be used. After this work had been done, the bracket was replaced on the stud and carefully drilled and reamed to the finished size. In preparing for the



Method of handling a Difficult Drilling Operation

drilling operation, the work was blocked up on the lathe bed to nearly the right height, but as the piece was of light weight it was an easy matter to hold it in line with the drill and also keep the stud against the dead center of the lathe. The work could be further supported by bringing the lathe carriage up against the back of the bracket.

Buffalo, N. Y.

RICHARD WILCOX

## AN UNUSUAL LATHE JOB

The machining of "outside" jobs that are beyond the capacity of the machines at hand frequently presents problems that require a different solution from those encountered in the regular shop work. A lathe job of this kind is shown in the accompanying illustrations which indicate the manner of machining this unusual piece of work at the Pond Works of the Niles-Bement-Pond Co., Plainfield, N. J. The special shaft to be machined has the following dimensions: Length over all, including square portion, 27 feet; diameter of threads, 10 1/2 inches; lead, 3 1/2 inches; half of cylindrical portion threaded right hand and half left hand; square part, 7 inches square.

As there was no lathe available with sufficient capacity and the necessary length of bed, two Pond 36-inch triple geared lathes that stood on adjacent foundations were selected for the job. From an inspection of the illustrations it will be seen that the headstock of one lathe and the tailstock of the other were removed and the beds were brought into

proper alignment. To prevent endwise motion of the beds, straps were used to join the end legs, the front strap being shown at A in Fig. 2. The same illustration also shows at B how the two lead-screws were joined by a suitable coupling for the purpose of feeding the tail-end carriage by power.

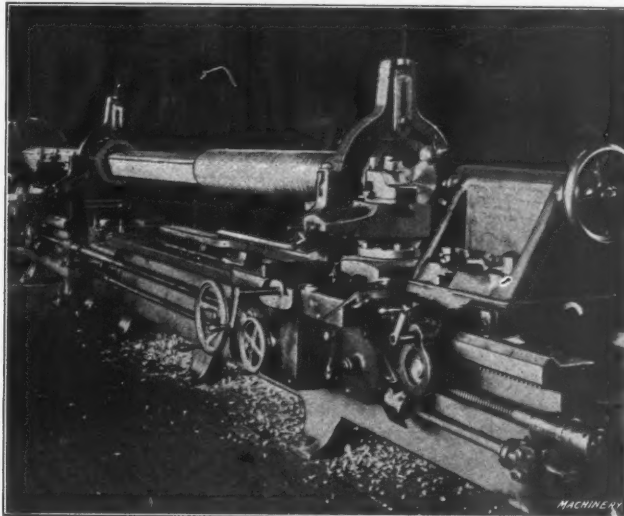


Fig. 1. Turning a Special Shaft on Two Pond 36-inch Lathes

It will be observed that bushings of ample proportions are provided for the steadyrests, which carry the principal weight of the shaft. The machining was accomplished in the usual manner, the shaft being turned end for end in order to reach the portion between the gap in the beds. The square part was machined on a planer after the shaft was rough-turned all over in the lathe.

Plainfield, N. J.

ALFRED SPANGENBERG

## SQUARE KEY VS. RECTANGULAR AND TAPERED KEYS

The article of this title which appeared in the March number of MACHINERY brought to mind certain experiences with keys on machine tools which may throw some further light upon the subject. It appears to the writer that a little more

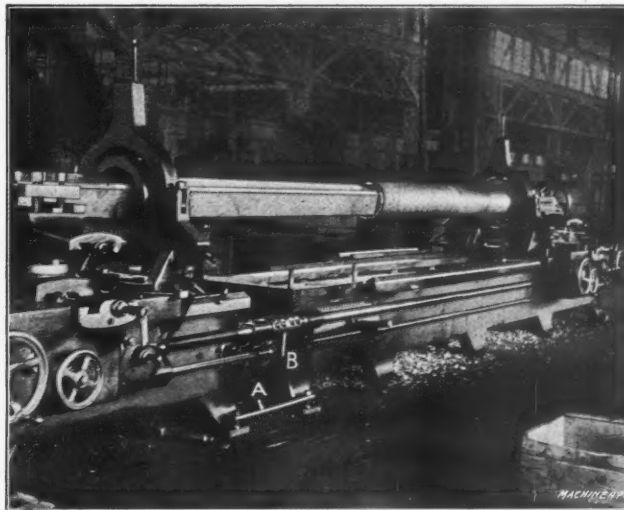


Fig. 2. Arrangement of the Leg Straps and Lead-screw Coupling

investigation of the work actually done by the keys, and not so much in the way of drafting-room calculations would result in more efficient designs, this being particularly true in the case of keys and bearings. Take, for instance, a pulley which is driven with a reversing motion, as in the case of belt-driven planers. A square key soon becomes loose both in the pulley and shaft, owing to the fact that the keyway is

too shallow to stand the strain. In repairing, it is necessary to compensate for wear in a way which makes the keyway both wider and deeper, but results in the use of a rectangular shaped key. Where this practice has been followed no further trouble was experienced and the shaft and pulley showed no signs of weakness.

Sliding members on spline shafts should have keyways of rectangular design in order to give more wearing surface on the side of the key, and will stand the strain of the drive better. There should be a key on each side of the shaft, as sliding members are less likely to stick, and wear is more equalized, especially in the keyways. This practice will be found to give satisfactory results on the shafts used on the upright drills with four or more heads, on cold cutting-off machines and a variety of other machine tools. As Mr. Wiweke says, a square key "fills the bill" and I agree with him in most cases, and also that keys should be made of larger size than is the present practice.

The chief objection to tapered keys is that they are sometimes very hard to remove. This difficulty is not experienced with straight keys, and such keys can be securely held in place by using a small set-screw as a retainer, carried in a hole tapped through the hub of the pulley. Such a design is used by a well-known firm of machine tool builders who manufacture draw-cut shapers. As for the weakening of the shaft by the keyway, I have never seen a shaft break at the point where the keyway was cut, and I have had experience in operating some very heavy planers. I have, however, had considerable trouble through small keys working loose, due to the fact that the keyseats were made too shallow. I have also seen cases in which the corner of the cast-iron pulley has broken off at the keyway, and other cases in which the key has failed by shearing.

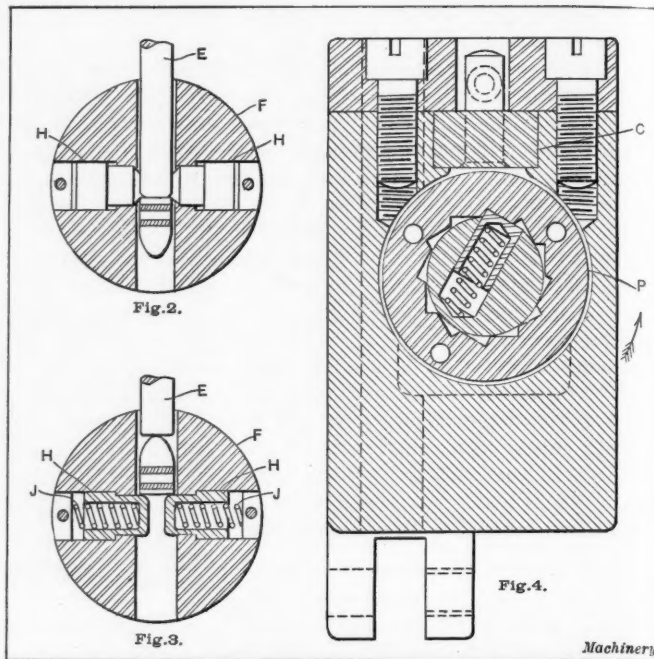
Dover, N. J.

J. L. DIGGORY

### AN AUTOMATIC FEED FOR BULLETS AND SLUGS

A device that feeds lead bullets or slugs to press tools in a uniform direction, regardless of the way in which it receives them, is shown in Fig. 1. The device is attached to a Waterbury-Farrel press with  $4\frac{1}{2}$ -inch stroke, and the bullets enter the tube *A* from a hopper located above the press. The hopper is equipped with an agitator tube and a lever for reciprocating this tube, which is moved up and down through the bullets and drops them into the tube *A*. The bullets are taken from the tube *A* by the slide *C*, which is operated by the cam *D* fastened to the cross-head, and carried under

the descending punch *E*. The punch-holder *L* is also carried by the cross-head. Should a bullet enter the tube *A* with the rounded side downward, as is the case with the first and third bullets shown in the tube *A*, it is pushed on through dial *F* and into the feed pipe *G* which carries it to the dial plate of the press. The dial, in turn, carries it under the working tools, and such operations as swaging or sizing are performed on it. The construction of the dial *F* and its action when a bullet happens to enter it in this position is shown in Fig. 2. The plungers *H* are chamfered on the end and the punch *E* forces them back against the action of the springs *J*, the



Figs. 2 to 4. Details of Feed Dial *F* and Clutch *P*

bullet dropping through the dial into the tube *G*. Should a bullet be in an inverted position, the action of the device is shown in Fig. 3. The flat bottom of the bullet rests on the straight portion of the plungers *H*; this prevents further descent of the punch *E*, spring *K* contracting back of it to take up the motion of the cross-head.

Carried in bracket *L* is the rack *M*, which meshes with the pinion *N*. The index plate *O* is doweled to dial *F* and the clutch *P* is fastened to sleeve *R*. Fiber friction washers *S* are used to prevent breakage should anything out of the ordinary happen. A section through clutch *P* is shown in Fig. 4.

When the cross-head descends, the rack *M* revolves the clutch in the direction shown by the arrow in Fig. 4. The dial *F* is held by the plunger *T* which enters a hole in the index plate *O*. When within  $\frac{1}{4}$  inch of the end of the down stroke (this position is shown in Fig. 1) the rack *M* strikes the lever *U*, pulling out the index plunger *T*. The rack descends far enough to give it time on its return stroke to move dial *F* before the returning index plunger can re-enter its former index hole. On the return stroke, the lost motion of the rack in its bracket gives time for the withdrawal of punch *E* before dial *F* is revolved, and this lost motion can be adjusted so that it reaches the highest point of the up stroke just as the dial *F* has revolved through 180 degrees to its other index hole. However, the friction washers *S* will allow for slippage should the rack carry too high. Referring to Fig. 3, it can be readily seen that the bullet is turned end for end when dial *F* is moved through 180 degrees. The bullet drops out of the dial and down pipe *G* to the machine dial in the same direction as the bullet entering in the opposite direction.

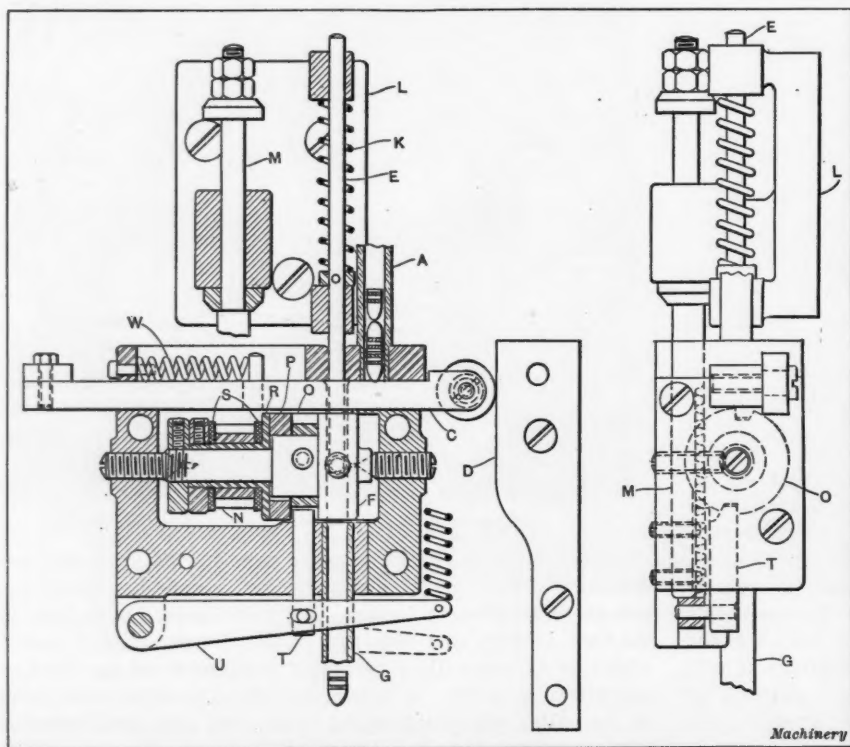


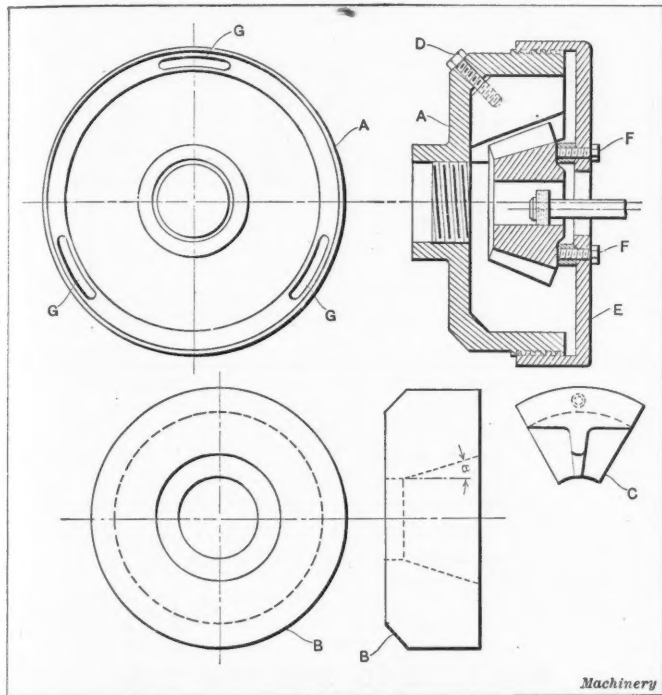
Fig. 1. Automatic Feed Mechanism for Bullets and Slugs

The dial *F* is carried on hardened centers to give accurate alignment, easy adjustment and light turning. The spring *W* is used to return the slide *C*.

LAWRENCE FAY

### BEVEL GEAR CHUCK

The accompanying illustration shows a chuck which I recently designed for holding bevel gears while grinding the hole. After the chuck *A* has been made, it is screwed onto the spindle of the machine and finished by grinding. The ring *B* is next made with the angle  $\alpha$  equal to the root angle



Chuck for holding Bevel Gears while grinding the Bearing Hole

of the bevel gear that is to be held in the chuck. Three jaws are cut out of this ring with teeth milled as shown at *C*. These jaws are made of a good grade of steel in order to enable them to stand up under hard usage. Holes are drilled and tapped in the jaws and the jaws are fastened in the chuck at 120 degrees from each other, one of the cap-screws used for this purpose being shown at *D*.

The chuck cover is shown at *E*, the gear being held in the chuck by the cover and screws *F*. To grind a bevel gear, the jaws are put in the chuck first and fastened by means of cap-screws passing through the three slots *G*, the screws being left loose enough to allow the jaws to adjust themselves to the gear. The bevel gear is next put into place and the cover screwed down on top of it. After the first gear has been set in place, the cap-screws *D* are tightened to hold the jaws ready for receiving subsequent gears. Care must be taken in putting gears in the chuck to see that there are no burrs left at the bottom of the teeth of the gear, as this would interfere with the action of the jaws in locating the work properly. The gear finished in this chuck will run within 0.001 to 0.002 inch true.

Farrell, Pa. JOHN BLANAR

### PREVENTING WEAR OF CONCRETE FLOORS

About the only objection to the ordinary concrete floor is the fact that the wear to which it is subject—that is, the purely

mechanical attrition—causes dust. This may, however, be avoided by scrubbing the floor with a stiff brush or broom, letting it dry, and then laying on a coat of a solution of water-glass in three to four times its volume of water. The solution is applied with a long-handled whitewash brush. The more dense the concrete, the thinner the solution may be, and no more of it should be made than can be applied in an hour. When the floor is again dry, it should be scrubbed with water and a coarse cloth. Then a second and a third coat of water-glass solution should be applied, each time letting the floor dry, scouring it with clean water and a heavy cloth. The water-glass should soak into the pores of the concrete and form with the alkali therein an insoluble chemical compound. Any water-glass that remains on the surface is unchanged, and can be washed or scrubbed away. This treatment will increase the durability of the concrete, and make it much more desirable as a floor material.

Dresden, Germany.

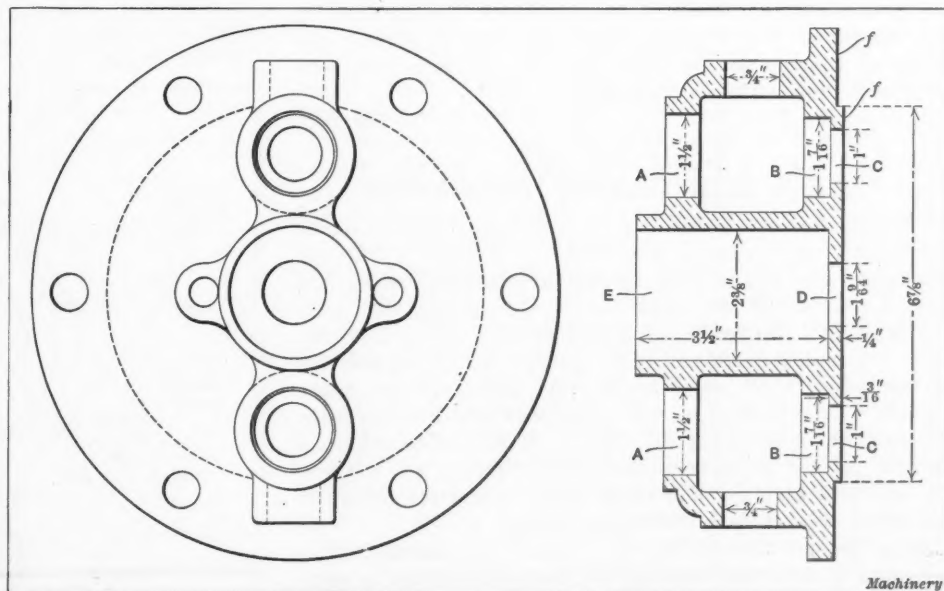
Robert GRIMSHAW

### RAPID PRODUCTION LATHE WORK

The accompanying illustration shows plan and cross-sectional views of a piece of work in which it was required to machine the holes *A*, *B*, *C*, *D* and *E* in a lathe. The first step in machining these castings was to chuck the work and finish the surfaces *f*, making the diameter of the boss 6 7/16 inches. The boss formed in this way was then used to hold the work in a plate jig. The plate jig was first located centrally on the faceplate of the lathe by means of dowel pins, and the hole *E* was then bored to size and finished to the required depth, the metal at the bottom of the hole being left 1/4 inch thick. The hole *D* was next bored.

The jig was then shifted to bring one of the holes *A* central and again held in position on the faceplate by dowel pins. It will be noticed that the finished size of the hole *A* is 1/16 inch larger than hole *B*, but both holes would be the same size in the rough casting. The hole *A* was first bored to a diameter of 1 7/16 inch, this size being carried nearly to the right depth in hole *B*. The tool was next moved away from the operator a distance of 0.221 inch and the hole *C* bored, the size obtained in this way leaving a little metal for reaming. Without changing the setting of the tool, the carriage was moved to the right so that the tool would clear the work. The tool was then moved toward the operator a distance of 0.252 inch and the hole *A* rebored to the required size.

The thickness of the plate jig was 11/16 inch, and adding the 3/16 inch required at the bottom of hole *B* gives a total distance of 1/2 inch as the required length of the pilot on the counterbore used to finish the bottom of the hole *B*. If this tool is pushed in until the end of the pilot is even with the back of the jig, the required thickness of metal will be left. I handled this operation without any trouble by proceeding as follows: A surface gage was set with the hook scriber 5



Difficult Lathe Job and Way in which it was handled

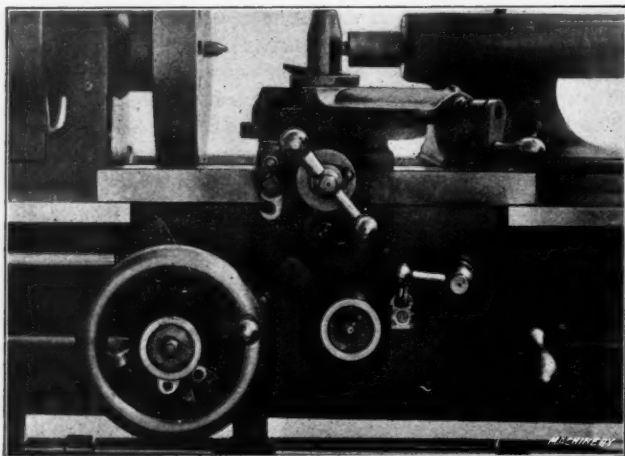
inches high, the surface gage being set against the faceplate of the lathe. The end of the pilot of the counterbore was then set at this distance from the faceplate. The counterbore was made with a taper shank to fit in the tailstock spindle, and by using the graduations on the tailstock spindle to work the tool in 5 inches from the original setting the desired thickness of metal was left at the bottom of the hole B.

In finishing the holes A, B and C on the opposite side of the casting, the work was simply turned through 180 degrees and then once more secured in place in the plate jig. The  $\frac{3}{4}$ -inch holes in the side walls of the casting were machined in a drill press. The wide-awake mechanic will find that there are lots of jobs that could be handled in this way with a saving of time and expense.

C. H. L.

### NO MORE BROKEN FEED PINIONS

During the past ten years that I have been teaching machine work, I suppose that no less than twenty-five times I have torn down a lathe, turned up a pinion and gear, and in some cases repaired the rack, all in a hurry to get the lathe ready for the class the following day. Some years ago I wrote a letter to the makers, saying that I thought it would be a great improvement if they equipped their lathes with "fool proof" aprons. I got back a very curt reply telling me that a lathe of the quality of those built by Blank & Co. was too fine a tool for an amateur to work on. However, the apron gear would be sent for about \$8 and express charges,



A Simple Method of preventing Feed Pinions from being broken

if desired. I understood then why the apron gear had ninety-nine teeth in it and required compound indexing to cut it.

Recently I discovered a very simple method of preventing the breakage of feed pinions. As shown in the accompanying illustration, there are two ears fastened to the wheel and the feed knob. When the feed is out, they are opposite; also, the lock hangs on a stud screwed into the apron and locks the feed nut open. I always keep the lock in one place or the other and find it much easier to move it to suit the workman than to fix the lathe after he has gotten in both feeds and broken the feed pinions.

Menomonie, Wis.

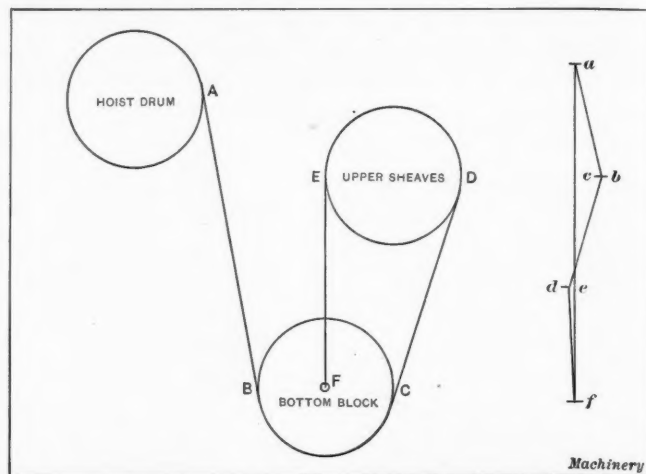
F. HILLIX

### A KINK FOR CRANE DESIGNERS

When laying out a crane trolley it is desirable to locate the bottom block with a fair degree of accuracy. The following outlines a graphical method by means of which the correct position of the block can be determined with ease and rapidity. The accompanying illustration shows a "three-part" lift arrangement, and it is required to find the position of the bottom block as it hangs from the drum and upper sheaves. The location of the drum and sheaves has been fixed and in determining the location of the bottom block, a position for the block is assumed which makes AB, CD and EF represent the directions of the ropes connecting the drum and upper sheaves with the bottom block.

After the position of the block has been assumed, it is necessary to determine whether the assumed position is satis-

factory. This is done by the graphical method illustrated herewith. The method of procedure is as follows: Draw a line *ab* parallel to AB, making this line of some definite length. Next draw a line *cd* parallel to CD, and then draw *ef* parallel to EF. The lines *cd* and *ef* are made of the same length as the line *ab*. This is due to the fact that the tension is practically uniform in the rope. If the position of the bottom block has been properly assumed, the closing line *af*



Graphical Method of locating a Crane Trolley Bottom Block

will be vertical; or in other words, the resultant of the rope tensions must lie in a vertical plane. If the line *af* is not vertical, a new position must be assumed for the bottom block and the same process gone through, the operation being repeated, if necessary, until a satisfactory position for the bottom block has been found. This method can be used for any arrangement of ropes.

Toledo, Ohio

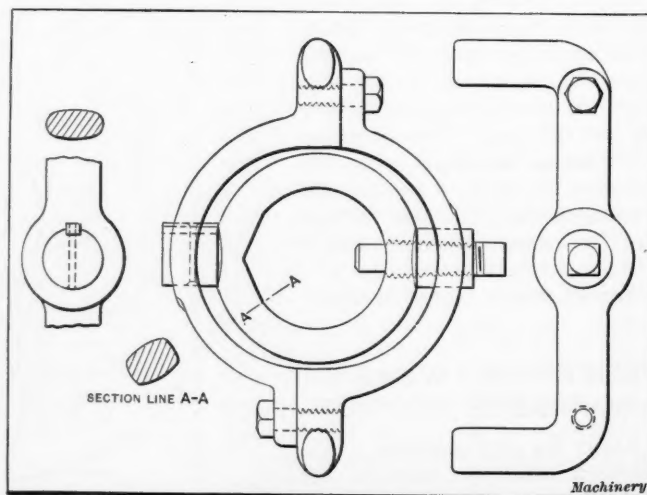
CARL E. SCHIRMER

### EQUALIZING DRIVING DOG

The accompanying illustration shows a driving dog with equalizing arms, which will be seen to consist of two rings. The inner ring is provided with a set-screw for fastening the dog to the work, and two trunnions which are a sliding fit in holes in the outer ring. In this way the two rings are flexibly connected to each other; the set-screw passes through the center of one of the trunnions and a key is attached to the opposite trunnion to prevent the rings from turning in relation to each other. It will be seen that the outer ring is made of two parts which are held together by means of cap-screws. In using this dog, it is necessary for the work to be placed nearly in the center of the inner ring as the equalizing feature is only sufficient to compensate for an eccentricity of  $\frac{3}{8}$  inch. The capacity of the dog is for work up to 3 inches in diameter. It would of course be possible to make the same type of dog in sizes to suit a variety of different classes of work.

Watervliet, N. Y.

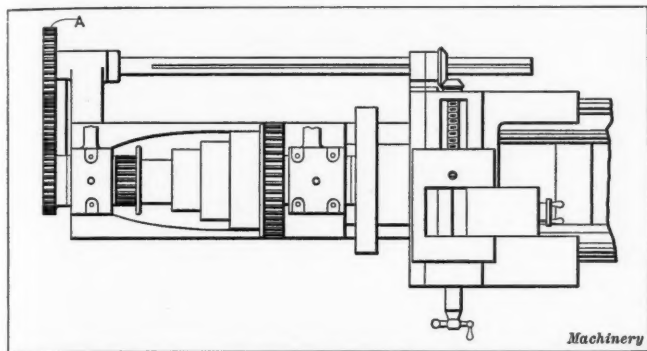
MARTIN H. BALL



Driving Dog with Equalizing Arms

### CUTTING A SPIRAL ON THE ENGINE LATHE

In the April number of *MACHINERY*, Russell K. Annis described a method employed in cutting a spiral groove in a disk and illustrated the attachment applied to a Lodge & Shipley lathe to adapt it for this operation. The accompanying illustration shows an attachment applied to a Fay & Scott lathe to adapt the machine for handling the same



Spiral Cutting Attachment for a Fay & Scott Lathe

class of work. It will be evident from this illustration that motion is transmitted to the cross-slide through spur gears at the end of the lathe and bevel gears at the cross-feed screw. The gear A is a change gear, different gears being employed for cutting spirals of various leads.

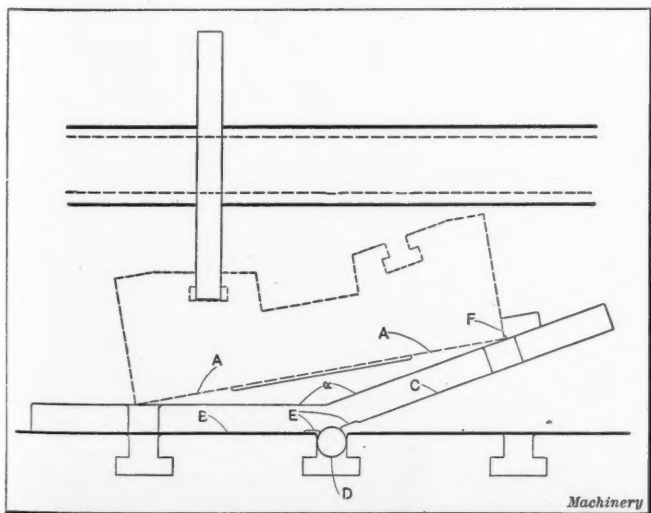
The attachment was designed to cut a spiral groove of two inches pitch in a fiber disk. In the writer's opinion this design is superior to the one described by Mr. Annis because only one cross-feed screw is required, which is also used for the regular work done on the lathe. In the attachment described in the April number of *MACHINERY* a separate cross-feed screw is required for each different lead of spiral that it is required to cut.

Dexter, Me.

E. W. TATE

### FIXTURE FOR MILLING T-SLOTS AT AN ANGLE

The fixture which forms the subject of this article was designed for milling two T-slots in a long casting, the T-slots being milled in two surfaces which are inclined to each other at an angle  $\alpha$ . The work is located in the proper position for milling the T-slots by means of the two finished bases B and C of the fixture, which are machined in the correct relation to the locating surfaces A and F. A rod D is fastened to the base of the fixture at the intersection of the two bases; this rod fits in the T-slot of the milling machine table and holds the fixture in alignment as it is swung from one side to the other. Recesses E are cut to allow room for a brush to be used to sweep away chips and dirt from under the fixture, so that it will fit properly against the milling machine table.



Fixture for milling T-slots in Surfaces inclined at an Angle

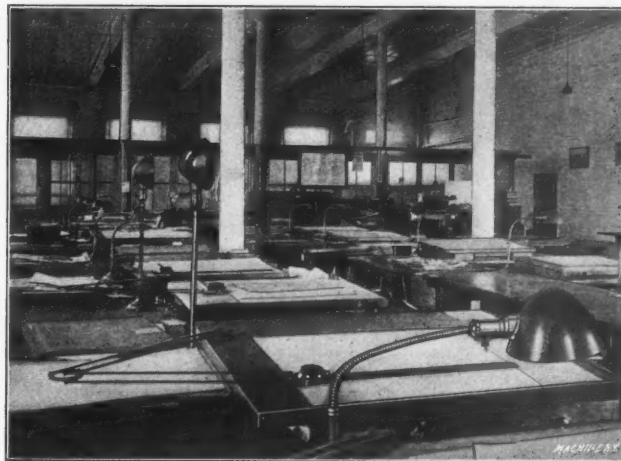
In starting to mill a piece of work, the casting is located against the finished face F of the fixture, and clamped in place with ordinary straps. The fixture is clamped to the milling machine table with the regular form of T-bolts. In milling the T-slots, two separate operations are involved; first, a cut is taken with a plain cutter as shown in the illustration, after which a second cut is taken with a T-slot milling cutter. In using the plain cutter, the cut is taken across the casting, and the table is then returned to the starting position, the quick return being used for this purpose. The fixture is next swung into position for milling the second slot, and clamped in place. The cross-feed is then employed to bring the cutter to the correct position, after which the second slot is milled. The cross-feed stops should be set so that all successive pieces will be uniform, without requiring attention from the operator. After milling the straight slots, the T-slot cutter is used in a vertical milling attachment. The operation is the same as in milling the plain slots except that the T-slot cutter will mill on both the forward and return movements of the table. Consequently, in milling the T-slots, the fixture will be indexed after completing the cut to provide for milling the second T-slot on the return of the table.

Providence, R. I.

C. KNOWLES

### GENERAL AND INDIVIDUAL ILLUMINATION FOR THE DRAWING-ROOM

It seems to be a most difficult problem to illuminate a drawing-room satisfactorily. Theoretically, at least, a soft, uniform, indirect light approximating daylight is to be desired, but the installation of such a system of lighting in an old room presents difficulties. In refitting as a drafting-room, a room for many years used for other purposes, the general scheme of lighting shown in the accompanying illustration has been employed with satisfactory results. The draftsmen



General System of Drawing-room Illumination and Individual Lights for Each Table

use the light without fatigue and the general illumination gives a bright, cheerful room.

As will be noted from the illustration, each desk is individually lighted by means of a 32-candlepower carbon lamp with frosted bulb. This lamp is supported in an 18-inch flexible arm fixture attached to the table at such a point as to be out of the way. A parabolic reflector, also adjustable, is used to direct the light onto the board in such a way as to prevent reflection into the eyes of the draftsmen. During the day the flexible arm is straightened up so that the lighting arrangement is entirely out of the way.

General illumination is by means of suspended 100-watt metal filament lamps. This system has been in use for about two years and on the whole with very satisfactory results. The arrangement, in addition to providing suitable illumination, is neat and mechanical in appearance. The wiring is carried along in conduits under each desk, the terminals being brought up through the floor where necessary. This eliminates unsightly wires coming down from the ceiling to the individual desks.

Holyoke, Mass.

W. M. FLEMING

### MULTIPLE THREAD CUTTING

The following outlines a method of using the compound rest for cutting multiple threads. Suppose you have to cut a double square thread of  $\frac{1}{4}$ -inch pitch and  $\frac{1}{2}$ -inch lead. Turn the compound rest so that it is at right angles to the cross-slide of the lathe and set the threading tool in the usual way. Now take the first cut, using the cross-feed screw to feed the tool into the work. Having taken a cut on the first thread, turn the compound rest crank to move the tool forward an amount equal to the pitch of thread to be cut, which is 0.250 inch in the present case. The graduated collar on the rest is conveniently used for this purpose. Next take two successive cuts on the second thread and then bring the rest back to the starting point and take a cut on the first thread. This is repeated until both threads are finished.

The only thing that the operator has to remember is to move the compound rest a distance equal to the pitch for each of the different multiple threads. If the screw in the rest is not provided with a graduated collar, scribe a line on the slide of the rest and onto its base. Then move the rest forward until the lines are separated by an amount equal to the pitch of the thread to be cut. These two lines can then be used in moving the tool backward and forward in the way previously described for a rest equipped with a graduated collar. The writer has found this method convenient for handling an occasional job of multiple thread cutting. There are no special fixtures to make and the lathe can be started and run continuously until the work is finished.

Richmond, Ind.

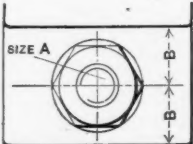
FRANK A. HIATT

### CLEARANCE ALLOWANCES FOR HEXAGONAL NUTS

The accompanying illustration shows the position of a hexagonal nut located close to a wall or boss, and the table gives the clearance allowance necessary to enable different sizes of nuts to be turned in such a position. The table is based on a movement of the wrench through an angle of 60

MINIMUM CLEARANCE ALLOWANCES FOR HEXAGON NUTS

Size of Nut A, Inch	Distance B, Inch	Size of Nut A, Inches	Distance B, Inches
$\frac{1}{8}$	$\frac{1}{8}$	$1\frac{1}{2}$	$1\frac{1}{8}$
$\frac{1}{4}$	$\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{1}{4}$
$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{7}{8}$	$1\frac{3}{8}$
$\frac{1}{2}$	$\frac{1}{2}$	$2$	$1\frac{1}{2}$
$\frac{5}{8}$	$\frac{5}{8}$	$2\frac{1}{4}$	$2\frac{1}{8}$
$\frac{3}{4}$	$\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{4}$
$\frac{7}{8}$	$\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{3}{8}$
$1$	$1$	$3$	$2\frac{1}{2}$
$1\frac{1}{8}$	$1\frac{1}{8}$		$2\frac{5}{8}$



Machinery

degrees. The information given has been found particularly convenient for reference in cases where the space available for the wrench is limited. The figures give the minimum clearance allowance in all cases.

Rochester, N. Y.

H. P. RESTON

### SLATE DRAWING BOARDS

In making preliminary sketches illustrating details on a large scale or explaining the details of a piece of machinery or part of a structure to customers, engineers, draftsmen or salesmen, nothing can be more satisfactory than the old-fashioned slate, pencil and sponge. Slate drawing boards of this kind are used by a tool manufacturing company in the western part of Massachusetts, and are said to be very satisfactory. A piece of slate about 3 by 5 feet in size is set in a solid frame, the edges of which are accurately finished so that a T-square and triangles can be used in the regular way. The slate drawing board can be used in place of the ordinary drawing board and detail paper; it is more economical and meets every requirement in making rough sketches and outline drawings. Small sharp slate pencils should be used, these pencils being kept pointed by means of an ordinary sandpaper pad.

A number of these slate drawing boards are used by the firm referred to in the preceding paragraph. Some of these are made of relatively thin slate, in which case a board support is provided in the frame under the slate to eliminate danger of breaking it. The frame is set on trestles of a convenient height. Some of the slates are also supported in an almost vertical position and the frames in which they are held are not provided with a board back. Consequently, it is possible to use both sides of a slate supported in this manner. The support is so constructed that the slate can be swung to from 10 to 20 degrees from the vertical.

Portions of drawings on such a slate can be readily removed and the remaining portions not only present a neat appearance but remain clear and sharply defined for an indefinite length of time. The great economy effected by having two or three of these slates about any drafting office will be readily appreciated, as everyone knows what a lot of paper is used up in preliminary work. In the course of a year, this saving of paper would easily pay for the slates several times over. Slate drawing boards of this kind can be purchased from any dealer.

Winter Hill, Mass.

FRANK H. JONES

### CUTTING SPIRALS ON THE LATHE

The article by Russell K. Annis entitled "Cutting a Spiral on a Lodge & Shipley Lathe," which appeared in the April number of MACHINERY, reminds me of another method which I saw used in a jobbing shop a number of years ago. A short shaft was journaled in brackets at the back of the lathe and the left-hand end of this shaft was fitted for a change gear. A disk turned to a circumference of eight inches was mounted on the shaft and one end of the main spring of a clock was attached to this disk. The other end of the spring was fastened to the cross-slide of the lathe, the cross-feed screw having been removed and a weight provided to pull the slide forward. In this way the cross-slide was held forward against the spring at all times.

Rotation of the disk caused the cross-slide to be moved over at the rate of eight inches for each complete revolution of the shaft. Consequently, by employing change gears on the shaft, it was possible to adjust the attachment to cut a spiral of the desired pitch. The spiral could be cut either right or left-hand by employing the feed reverse in the headstock.

The shop in which this method was employed also had a lot of chucks to machine. These chucks were used on some sort of wood-working lathe and had a tapered hole 4 inches in diameter at the large end, the taper of the hole being approximately 75 degrees included angle. It was required to cut a coarse buttress thread inside this hole, and the clock spring arrangement previously described was used in connection with the lead-screw, enabling what would otherwise have been a difficult job to be handled with considerable rapidity.

Later, this attachment was put into a more permanent form by placing a gear of eight inches pitch circumference on the shaft and providing a rack on the cross-slide to mesh with it. This rack and gear was substituted in place of the disk and clock spring, but not until the original device had proved its utility by producing several hundred of the spiral chucks.

New London, N. H.

GUY H. GARDNER

### DIFFERENT METHODS OF DRAWING A GIB

In reply to W. Butz's question in the April number as to the correct method of drawing a gib, his illustration A is considered correct. Since the side view is larger than the end view, the first glance at the former will give the determining impression to the workman. At A, the workman sees the extreme lines in the side view and he also sees two other lines, one solid and the other dotted. He at once realizes that there is something else to the gib which is not shown in the side view; then he will look more closely at the end view, obtaining at once the over-all dimension of  $\frac{3}{4}$  inch and the necessary bevel.

In the illustration *B*, the side view appears somewhat similar to a rectangular bar and the workman is likely to take the size  $\frac{5}{8}$  inch and the size  $\frac{3}{16}$  inch without looking further, thus getting a bar that will be impossible to finish to the required size. Also he sees an angle of 60 degrees and is likely to waste some time in guessing how to chuck it to plane the bevels. If the workman has had no more education than that obtained in the sixth or seventh grade, he will be at a loss to know how to figure out the complement of the angle 60 degrees.

Illustration *C* brings the worst predicament of all. While at first glance, the side view appears identical with the corresponding view *A*, the dimensioning is vague and incomplete. The workman as a rule is not versed in trigonometry, even if he has had training in that subject in the schools, owing to the fact that he has little use to handle that subject in his work. Taking the dimension of  $\frac{11}{16}$  inch, he will potter around making sketches in order to obtain the missing dimension on either side.

Draftsmen often take for granted that the workmen has had an education equal to his own. But the workmen, as a rule, are recruited from the sons of men already employed in the shops, and at the age of fifteen or sixteen years, so that their education is necessarily incomplete. The simpler the drawing is, with complete dimensions accurately placed, the quicker and more correctly will the workman grasp the idea of what is intended to be made.

Dallas, Tex.

SIDNEY HETHERINGTON

### HOW ANOTHER PIECEWORK RATE WAS SMASHED

I have enjoyed reading the short article in the April number of *MACHINERY*, entitled "How a Piecework Rate was Smashed," and am tempted to write of my own experience with a piecework job. While working as a bench hand in a factory making various electric recording instruments, I was given the job of straightening some very thin aluminum tubes about  $\frac{1}{8}$  inch in diameter and 6 inches long. These tubes were used to convey ink to the pen of the instrument and had to be absolutely straight. The foreman and best mechanics had studied over the job each time a lot came through, but the best method they could find was to roll them between two surface plates. The tubes were so thin, however, that many of them were crushed; indeed it was not unusual to spoil 20 per cent of the work.

Well, I was given this job at a price of 25 cents per hundred and started to work. It seemed as though I spoiled every other tube. I then began to experiment. Finally I hit upon the idea of holding one end of the tube in the spring chuck of a bench lathe, starting up the lathe and then drawing my hand along the tube to the end. The result was a perfectly straight tube in an instant. I finished the lot of 4000 in about six hours; also taking care that the "boss" did not see my method. Then I took the work up to him.

He nearly collapsed when he looked at the pile of finished tubes and saw only a dozen or so broken. He rolled them back and forth to see if they were really straightened. Then he asked how I had done the job. This was where my trouble commenced, for I would not tell how I did the work, or submit to a cut, so I was allowed to resign. I got my \$10 for six hours' work, but I never found out whether or not the company discovered my method. Some of the workmen knew it and I suppose they told after I left.

J. A. D.

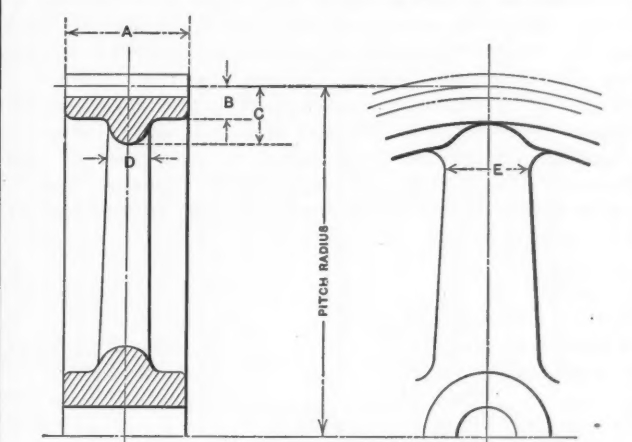
### DIMENSIONS OF SPUR GEAR RIMS IN RELATION TO THE PITCH

I have to sketch and estimate the weight of a great many spur gears in the course of a year, and to facilitate this work I have prepared a table covering the thickness of rim, the depth of the bead inside the rim, and the breadth and thickness of the outer ends of the arms of the gear. This table, which is presented herewith, is very useful to me and I offer it in the hope that it may be of service to other readers of *MACHINERY*. It will be seen that the sizes are given in connection with both the circular and diametral pitch of the teeth, as well as the correct face width for each pitch.

In many cases the information furnished to the designer is very meager, and in the case of gearing this is particularly true. To the lay mind, a gear wheel is "about so big and has a certain number of cogs." This paucity of specific information in regard to matters of fundamental importance is the bane of the designer's life. If, however, he is fortunate enough to be given the horsepower, speed and approximate diameter of the gears, the accompanying table will be found useful. Experience alone will teach the designer the most satisfactory pitch to assume for a given set of conditions, but reference to the table will show the correct face width of the gear for the pitch assumed. The designer is now ready to figure the horsepower which the wheel will transmit. Lewis' formula is as good as any and better than some formulas that are in quite general use.

Reference to the table will now enable him to determine the thickness of the rim and the size of the bead and arms of the pulley. In the matter of estimating the weight of

DIMENSIONS OF SPUR GEAR RIMS IN RELATION TO THE PITCH



Circular Pitch, Ins.	Diametral Pitch	A	B	C	D	E	Circular Pitch, Ins.	Diametral Pitch	A	B	C	D	E
$\frac{1}{8}$	4	$1\frac{1}{8}$	$\frac{1}{8}$	$1\frac{1}{8}$	$\frac{1}{8}$	$1\frac{1}{8}$	2	$1\frac{1}{8}$	6	$1\frac{1}{8}$	$3\frac{1}{8}$	$2\frac{1}{8}$	$4\frac{1}{8}$
$\frac{1}{4}$	3	$2\frac{1}{4}$	$\frac{1}{4}$	$2\frac{1}{4}$	$\frac{1}{4}$	$2\frac{1}{4}$	2	$1\frac{1}{4}$	7	$2\frac{1}{4}$	$3\frac{1}{4}$	$2\frac{1}{4}$	$4\frac{1}{4}$
$\frac{3}{8}$	2	$3\frac{3}{8}$	$\frac{3}{8}$	$3\frac{3}{8}$	$\frac{3}{8}$	$3\frac{3}{8}$	2	$1\frac{3}{8}$	8	$2\frac{3}{8}$	$4\frac{3}{8}$	$3\frac{3}{8}$	$5\frac{3}{8}$
$\frac{1}{2}$	1	$4\frac{1}{2}$	$\frac{1}{2}$	$4\frac{1}{2}$	$\frac{1}{2}$	$4\frac{1}{2}$	2	$1\frac{1}{2}$	9	$2\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{1}{2}$	$6\frac{1}{2}$
$\frac{5}{8}$	$\frac{3}{4}$	$5\frac{1}{4}$	$\frac{3}{4}$	$5\frac{1}{4}$	$\frac{3}{4}$	$5\frac{1}{4}$	3	$1\frac{5}{8}$	10	$2\frac{5}{8}$	$6\frac{5}{8}$	$5\frac{5}{8}$	$7\frac{5}{8}$
$\frac{3}{4}$	$\frac{4}{5}$	$6\frac{3}{4}$	$\frac{4}{5}$	$6\frac{3}{4}$	$\frac{4}{5}$	$6\frac{3}{4}$	4	$1\frac{3}{4}$	12	$3\frac{3}{4}$	$8\frac{3}{4}$	$6\frac{3}{4}$	$9\frac{3}{4}$
$\frac{7}{8}$	$\frac{8}{9}$	$7\frac{7}{8}$	$\frac{8}{9}$	$7\frac{7}{8}$	$\frac{8}{9}$	$7\frac{7}{8}$	5	$1\frac{7}{8}$	14	$4\frac{7}{8}$	$10\frac{7}{8}$	$8\frac{7}{8}$	$11\frac{7}{8}$
1	1	8	1	8	1	8	6	2	16	5	12	9	13
1	1	8	1	8	1	8	6	2	16	5	12	9	13

the gear, the use of the table eliminates about one-half the calculation that would otherwise be necessary. The number of cubic inches of metal having been found, this is multiplied by the constant 0.27 in the case of cast iron and 0.29 for steel, the result being the weight of the gear in pounds. The usual constants for the weights of a cubic inch of iron and a cubic inch of steel are 0.26 and 0.28, respectively. Experience has shown me, however, that the higher constants are more accurate for gear work, taking care of the excess weight resulting from rapping the pattern in molding. In very large gears, with arms of I-section, made with cores, allowance must also be made for the core shrinkage and consequent thickening of the metal sections. In large gears this allowance often amounts to between 150 and 200 pounds. The fillets in large gears should be figured separately by referring to *MACHINERY'S* Data Sheet No. 59, and the result obtained added to the weight of the gear as figured from the table.

Oakdale, Pa.

EDGAR H. TRICK

### PATENTABLE INVENTIONS

The address of Prof. Hutton, referred to in the April number of *MACHINERY*, appears to discuss two distinct topics: "Data" is the subject of the first three basic questions propounded; and "Patentable Inventions," the subject of the

fourth basic question. The distinction between these subjects is quite clearly brought out by the judicial opinion in *Fuller & Johnson Co. vs. Bartlett*, 68 Wis. 73, a recognized case concerning the relation of employer and employee as regards patentable inventions. The opinion reads: "The mere fact that in making the invention an employee used the materials of his employer, and is aided by the services and suggestions of his co-employees and of his employer in perfecting and bringing the same into successful use is insufficient to preclude him from all right thereto as inventor. The same is true of an invention conceived wholly by an employer and then perfected under his supervision by the aid of the mechanical skill of his employees. These propositions are sanctioned by numerous adjudications."

"The difficulty with the contrary assumption arises from confounding the machine with the invention which it embodies. Of course there must be a machine that will operate before it can be patented. That implies material, workmanship and skill combined. But such combination, of itself, is not enough to secure a patent. It must also embody an original conception of a new and useful method of doing a specific thing. It is this conception, so embodied, evolved from the inventive faculties of the inventor which constituted the invention in question. The law gave him the exclusive property in it. He still retains it except in so far as he has parted with it or agreed to part with it. The material, workmanship and skill which embodied the invention remain the property of the plaintiff (the employer).

The workmanship and skill are both the results of instruction, experience and knowledge. They are acquired by being learned. They may aid and stimulate invention, but are no part of it."

The Federal Supreme Court and other courts have decided, even where one is employed to perfect, improve and to develop new devices, that the employer can acquire no exclusive title to inventions made by the employee in the course of the latter's employment, unless the employee is bound by a specific contract to assign such inventions. (Besides the above noted case see also *Hapgood vs. Hewitt* 119 U. S. 226; *Barber vs. National Carbon Co.* 64 C. C. A.; *Slemmers Appeal* 58 Pa. 155.) If the person who is engaged to improve and to develop new devices is privileged to hold title to such inventions, how much more should the subordinate be entitled to his own inventions and to whatever advantage he may secure through them, when such inventions are made entirely outside of his sphere of action—services not contemplated in his contract of hire. The reference data, including drawings, appear to partake of those attributes—material, training, knowledge, skill—which the court said belong to the employer.

If the principles above set forth are controlling, then the six reasons back of the ethical practice suggested by Prof. Hutton have no application to his fourth basic question. If a draftsman really *invents* something of value to his employer, the latter should not feel that he is being "held up" because that employee invokes his legal rights to secure the best advantage from his creation. If the invention is so important that the employer's operations are literally "held up" for the lack of it, it certainly must be worth something more than the weekly stipend of the draftsman, which would probably have continued even though no invention had been made. It should be gratifying, at least, that the improvement had been made by an employee rather than by a competitor.

Upon what theory does the possession of ample resources or of an adequate plant entitle an employer to the fruits of an employee's inventive creations? The resources may be

running to waste and the plant may be dying of dry rot. An employee who devises an improvement or creates a new output which turns the waste into channels of usefulness is as much entitled to a share in the returns which he has produced as the man who helps a weak concern to its feet by supplying necessary capital. Why should not employers subscribe to a code of ethics which embodies a professional obligation not to appropriate the valuable inventions made by their employees?

Central Falls, R. I.

EDWIN C. SMITH

## SAFETY DEVICE FOR LIGHTNING SCREW-DRIVERS

The present forms of "lightning" screw-drivers are much faster and handier to use than a common screw-driver, but the designers and manufacturers of these tools have overlooked an important feature. Men who have to use these screw-drivers are continually pinching their hands in them, and to avoid these small but painful accidents it was suggested that some sort of guard be developed. The accompanying illustration shows the upper and lower ends of the screw-driver in which the tool-holder is marked A. This tool-holder is fastened to the driving screw B by means of a small pin D. The tool-holder A revolves in a brass sleeve E which is fastened in the aluminum guard and handle F by the grub screw G; this screw passes through the sleeve and guard holding them firmly together. The hole shown at H

allows the pin D to be driven in or removed when it is necessary to take the tool apart.

The sleeve C comes down to the lower handle and is the part which was formerly responsible for pinching the workman's hand. This has been overcome by the provision of the guard

F which allows the sleeve C to move inside it. This guard has been thoroughly tested and has proved satisfactory in every respect; it takes up very little room and makes the tool only a trifle heavier than one with a wooden handle. In addition to the protection afforded, the guard is the means of increasing the speed with which the operator works, as he is not afraid of pinching his hand in the screw-driver. The illustration also shows the upper handle of the tool which is usually made of wood. If the screw-driver happens to fall on the floor, the wooden handle is likely to break and cause a lot of trouble in patching up the broken handle or making a new one. To avoid this difficulty, an aluminum handle has been substituted in place of the wooden one. It will be seen that the handle is recessed at J in order to reduce the weight.

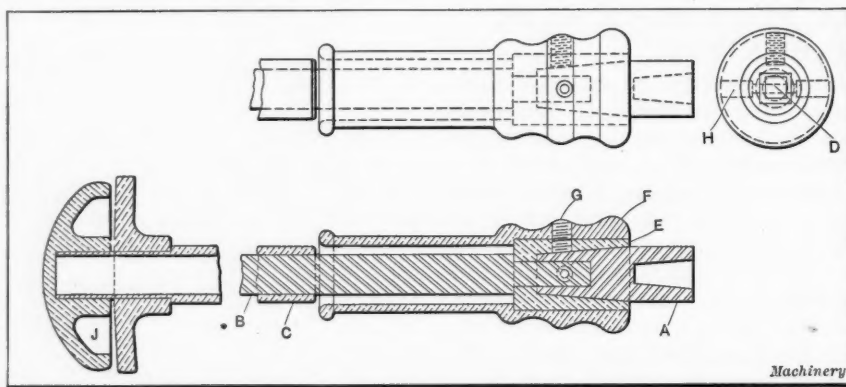
Grand Rapids, Mich.

GEORGE H. HAMILTON

\* \* \*

## APPROPRIATION FOR MUSEUM OF SAFETY

The American Museum of Safety, an institution devoted to the safety, health and welfare of industrial workers and the advancement of science and industry, with headquarters in New York City, has been placed on a footing with the Metropolitan Museum of Art and the American Museum of Natural History by the New York Legislature, which has authorized the Board of Estimate of New York City to contribute not more than \$50,000 yearly to the expenses of the museum. Eventually the trustees hope to erect a noble building in which to house the museum's exhibits of safety appliances, anatomical models, occupational dusts, charts, photographs, slides, etc. The museum has a special charter from the State of New York and this latest substantial recognition of its usefulness indicates that its dream may be realized in the not distant future.



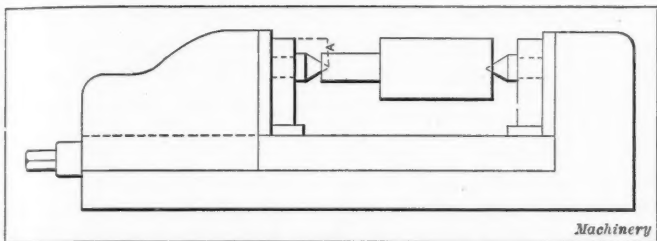
Cross-sectional View through Screw-driver showing Safety Device and Aluminum Handle

## SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

### SHAPER CENTERS

In a great many shops shaper centers are not always available, and often, when they are, they cannot be used for work that should be shaped on centers, on account of the shank of the work being too short to leave room for a dog. The accompanying illustration shows a pair of centers which work very satisfactorily, being especially suitable for machining small blanking punches where the punch is shaped right



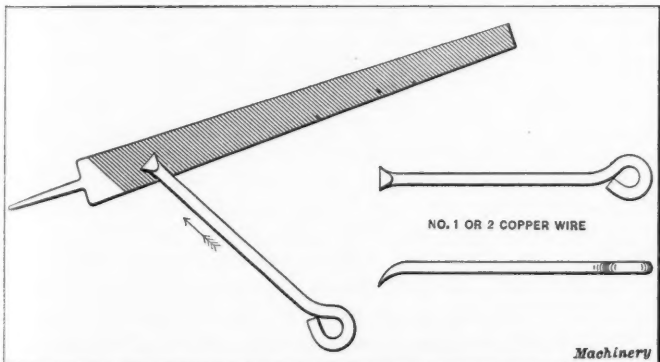
A Useful Form of Centers for Use on the Shaper

up to the shank. These centers may not look practical to many people on account of the work having a tendency to slip, but experience showed that they stood up satisfactorily under a  $\frac{1}{8}$ -inch chip 2 inches from the center. This cut was taken without clamping the jaws much tighter than would be necessary for holding work between the jaws of a vise. Another good point is that in shaping different polygons, a protractor or square can be set on the bed of the vise and the side of the work, thus enabling the operator to proceed without resorting to the use of cut-and-try methods. The distance *A* on the drawing should be made an even fraction of an inch—say  $\frac{1}{2}$  inch or  $\frac{3}{4}$  inch—as this helps greatly in setting the tool.

C. G.

### FILE CLEANER

An excellent file cleaner can be made by flattening a piece of No. 1 or No. 2 copper wire, and bending the flat side over as shown in the accompanying illustration. An eye is formed at the other end to provide a handle, and the flat end is



Efficient Form of File Cleaner made of Copper Wire

ground down to a thickness of about  $\frac{1}{32}$  inch. This sharp edge is pressed on the file and moved back and forth in the direction of the milling. It soon takes the impressions of the milling and cleans out all residue that is held in the teeth.

Downieville, Cal.

CLARENCE I. SIMMONS

### SPACING LETTERING AND SECTION LINES

In the January number of MACHINERY, R. F. Pohle describes a very good method of spacing the section lines on drawings. I have had experience with another method of doing this work which I consider even better than the one described by Mr. Pohle. I take a Starrett V-thread gage which can be obtained with any number of divisions to the inch from six to sixty, inclusive, so that any desired spacing can be obtained. The gage is pressed onto the paper and leaves impressions in which the point of the pencil is lo-

cated preparatory to drawing each section line. The lines are drawn with a T-square and triangle in the usual way. I have used this method for a number of years and thought that it might prove of value to readers of MACHINERY. The gages are not expensive so that a draftsman can afford to buy those having the spacings which he has occasion to use quite frequently. They are of compact form so that they occupy very little room in the instrument case.

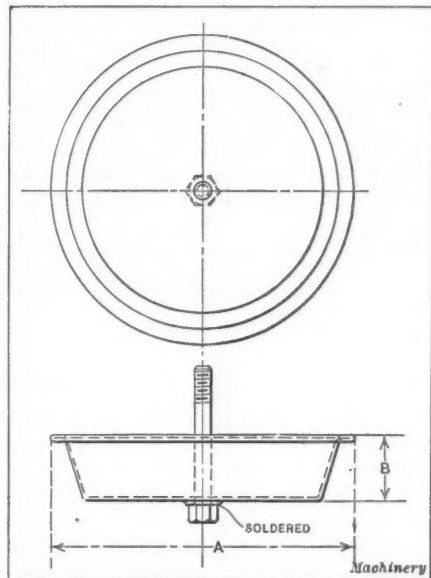
Los Angeles, Cal.

GUSTAVE STEINKE

### DRIP-CUP FOR COUNTERSHAFTS

In most factories an oil-cup is fastened to each hanger or countershaft to catch surplus oil and prevent it from dripping onto the floor. These cups are usually cast-iron devices which are cumbersome and have been known to injure men passing under-

neath, owing to the cup having worked loose through vibration. I recently saw a drip-cup made of sheet metal which seems to meet all requirements without having the objectionable features of the cast-iron cups. Reference to the accompanying illustration will show that this cup is fastened to the hanger by a bolt and it is made of such light material



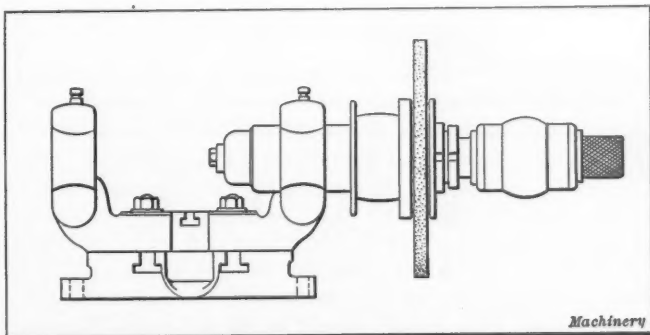
Sheet Metal Drip-cup for Use on Countershafts

that the tendency for it to work loose through vibration is practically eliminated. The diameter *A* and depth *B* of the cup can be made to suit the requirements of individual cases. Thousands of these cups are in use in the factory referred to and they have been found to be entirely satisfactory.

G. A. A.

### CHANGING WHEELS ON B. & S. GRINDERS

It is frequently necessary to change the wheels on a grinding machine to meet the requirements of different classes of work, and unless the operator is careful the wheels are likely to be broken. The writer has found that by clamping one bearing in the grinder stand—allowing the arbor to over-



Method of changing Wheels on B. & S. Grinders

hang—rigid support is provided and both hands are free for use in removing one wheel and mounting a new one in its place. The idea is clearly shown in the illustration without requiring further description.

Bristol, Conn.

LEWIS L. LEIGH

## HOW AND WHY

## QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

## TO ROLL ROUND TUBING TO OVAL SHAPES WITHOUT BENDING OR TWISTING

K. G.—Can you tell me how to roll round tubing to an oval shape without bending or twisting? The tubing is 22 gage by  $\frac{1}{2}$  inch diameter. We force it through a set of rollers which can be set to the size desired.

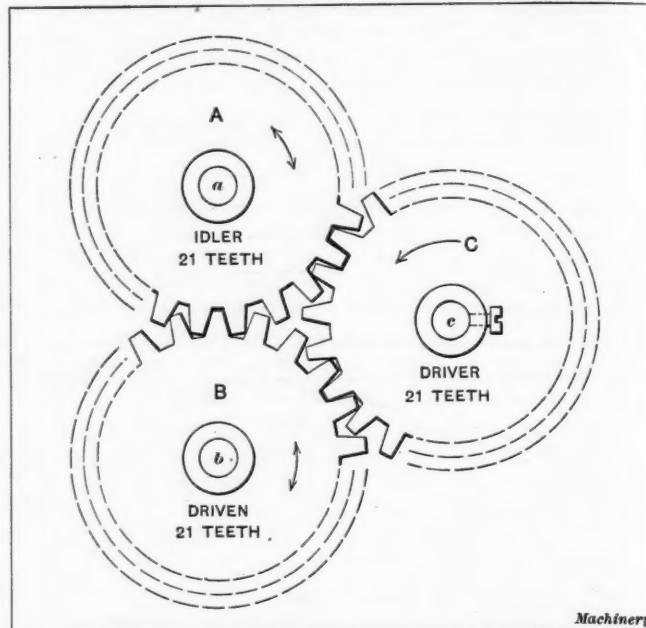
The question is referred to the readers for suggestions.

## BELT CONVEYOR PULLEY DIAMETERS

O. E. B.—The illustration shows drums and gearing designed to drive a belt conveyor 430 feet long center to center, rise  $4\frac{1}{2}$  inches per foot and carrying approximately 600 tons of stone per hour. In order to get proper belt contact without excessive diameters of head drums, the construction shown was adopted. The driving pulley is mounted on the same shaft as gear A and drives the drum D, through the train of gears A, B, C, D and E. The gears D and E are of the same diameter and the belt is approximately  $\frac{5}{8}$  inch thick. The question is, should the drum D, be larger than D, or not? If larger, how much so? I believe that D, should be slightly larger than D, but cannot decide how much. If we assume that the speed of a point about a center varies as the distance from that center, it follows that a point on the inside of a belt travels 6.65 feet slower per minute than a point on the outside when D, makes 20 revolutions per minute. The speed on the inside is approximately  $251\frac{1}{3}$  feet and the speed on the outside about 258 feet per minute.

A.—The diameters of drums D, and D, should be the same. The fact that D, drives the belt from one side and D, from

C. I desire to make gears A and B smaller than C and would like a formula for determining the diameters and numbers of teeth of A and B which will have the same relation to C as they have in the illustration. In other words, I wish to



Machinery

shift A or B into mesh with C without changing the angular positions of the gears.

The problem is submitted to the readers for discussion.

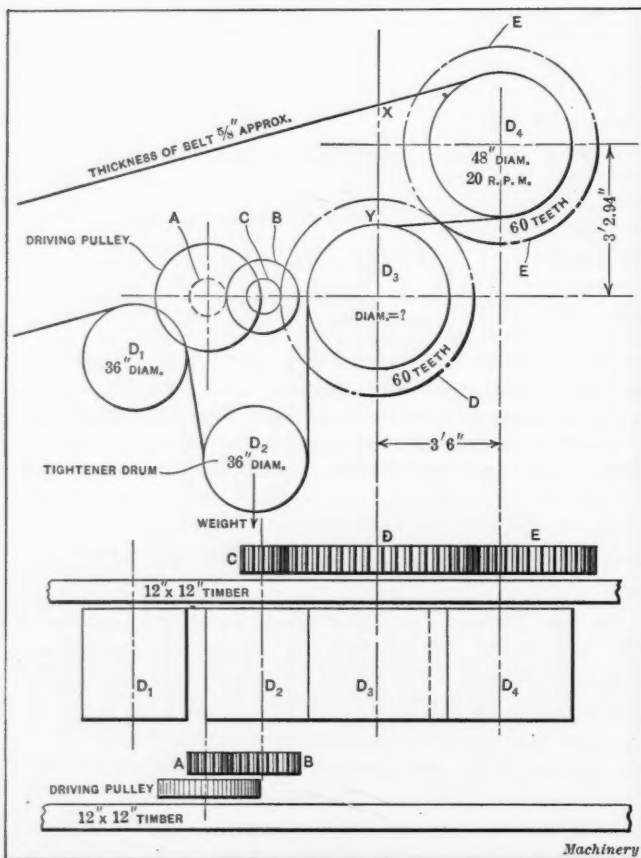
## DESIGN OF CRANE-LADLE HOOKS AND TRUNNIONS

J. P. P.—The accompanying illustration Fig. 3 shows a crane-ladle with cast steel trunnions riveted to it, these trunnions being engaged by cast steel crane hooks. The total weight of the ladle when filled with molten steel is 120,000 pounds. I would like to see the results of calculations to determine the required diameter  $d$  of the trunnions and the dimensions  $d_1$  and  $t$  of the crane hooks. What I would particularly like to know is the approved method of making these calculations. I was recently called upon to design trunnions and hooks for this ladle and have worked the problem out, but would like to check my results.

Answered by William L. Cathcart

The crane hook engaging each trunnion carries a load of  $120,000 \div 2 = 60,000$  pounds. The ladle and its trunnions may be considered either as a simple beam, supported by the hooks and loaded at the inner ends of the trunnions, as in Fig. 1; or each trunnion may be regarded as a cantilever, supported at the ladle and bent upward by a force  $P = 120,000 \div 2 = 60,000$  pounds. In either case, the bending moment  $M$  at the trunnion support is equal to the product of  $P$  and its distance from that support. The total length of the trunnion is given as  $4\frac{1}{2}$  inches, which would make  $P$  act at a distance  $p = 2\frac{1}{4}$  inches from the support. The trunnions are to be of cast steel. In some very carefully conducted tests of this metal, Prof. Bach of Stuttgart\* found an elastic limit of 33,467 pounds per square inch and an ultimate tensile strength of 61,543 pounds per square inch. In the calculations given below, an allowable working stress of 10,000 pounds per square inch is used, that is, the factor of safety is 6. Under the downward thrust of the weight and the upward pull of the hook, the trunnion bends upward, being thus in tension on the lower side and in compression on the upper. The general formula for bending at any section of the trunnion is  $M = SI \div c$ , in which  $M$  = bending moment at the section considered = moment at the support, as above;  $S$  = allowable working stress;  $I$  = moment of inertia of the cross-section of the trunnion at that point; and  $c$  the distance of the most remote fiber of that cross-section from the neutral axis, which axis lies in the plane of the

\* Zeitschrift des Vereines deutscher Ingenieure, June 10, 1899.



Machinery

the opposite side need not be taken into consideration. The speed of the belt should be figured on its pitch line, that is the center line of the belt. The belt theoretically travels at the rate expressed by  $2(R + t) \times 3.1416 \times R. P. M.$  in which  $R$  is the drum radius and  $t$  one-half the belt thickness. This travel rate evidently should figure out the same for both drums; hence, both drums should be of the same diameter.

## REVERSING GEAR

W. E. D.—The illustration shows a reversing gear in which the three gears have the same diameters and numbers of teeth—21. C is the driving gear; B, a driven gear and shifting gear; and A, a shifting gear. A and B are always in mesh and one or the other is slid on the shaft into mesh with

cross-section and passes through its center of gravity, that is, through the center of the trunnion.

For a trunnion  $4\frac{1}{2}$  inches long and of diameter  $d$ ,  $p = 2\frac{1}{4}$  inches and  $M = P \times p = 60,000 \times 2.25 = 135,000$  inch-pounds. Substituting this value in the formula, as above, and  $I = \pi d^4 \div 64$ ,  $c = d \div 2$ , and  $S = 10,000$  pounds per square inch:

$$135,000 = 10,000 \times \frac{\pi d^4}{64} \times \frac{2}{d}$$

$$d^3 = 137.5$$

$$d = 5.16 = 5\frac{3}{16} \text{ inches (approximately).}$$

For other lengths of trunnions, the diameters computed in this way are given in Table I. In machine members subjected to repeated shocks, factors of safety of 10 for wrought iron and 15 for steel are frequently used. A fairly high

factor—possibly greater than 6—is advisable in this case; first, because the trunnions are to be castings, a condition which always involves some uncertainty—although this element is decreasing with the progress in heat-treatment—and, second, because they may at times be suddenly overloaded either in emergency or through careless handling.

For example, if

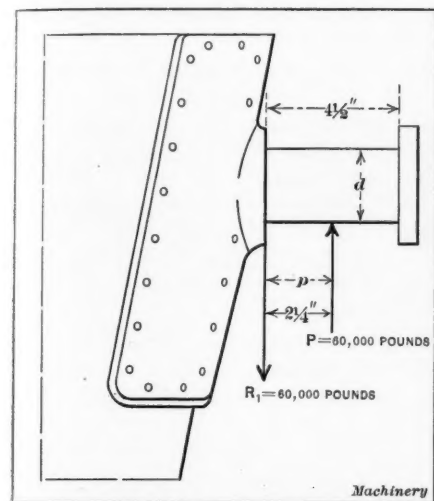


Fig. 1. Detail of Trunnion attached to Crane Ladle

the full ladle were lifted very quickly, its weight would become a suddenly applied load having, in strain and stress, twice the effect of a static load. Again, if the ladle while lowering were suddenly checked, its kinetic energy would produce an additional and suddenly applied load whose magnitude would depend on the velocity of descent and might be relatively large. Finally, the trunnion is abraded and worn by the hook at the middle.

#### Dimensions of the Crane Hook

Practice as to dimensions of crane hooks varies considerably. Taking an allowable stress of 10,000 pounds per square inch, there are given in Table II the desired dimensions, computed from the formulas of A. E. Holcomb, as stated in Kent's "Pocketbook," 1912. The tabulated trunnion lengths are those for which the diameters were calculated. The extreme width  $b$  of the hook, Fig. 2, plus the clearance, is the factor that determines which of these lengths is practicable. It will be seen that, according to these formulas and with this working stress, it is not possible to design a 30-ton crane hook for a trunnion  $4\frac{1}{2}$  inches long, when both are of cast steel. Under average conditions of service, the working stress for cast steel hooks of this size should not exceed 11,500

TABLE I. DIMENSIONS OF TRUNNIONS AND VALUES OF BENDING MOMENTS

Length of Trunnion, Inches	Bending Moment, Inch-pounds	Diam. of Trunnion $d$ , Inches
5	$60,000 \times 2.5$	$5\frac{3}{16}$
$5\frac{1}{4}$	$60,000 \times 2.75$	$5\frac{1}{2}$
6	$60,000 \times 3$	$5\frac{1}{4}$

pounds per square inch, while that of wrought iron may be 17,500 pounds per square inch, and 23,000 pounds per square inch has been used for hammered steel. The hook meets the same shock and sudden overload as the trunnion. A low working stress in the latter makes the diameter large; a large diameter increases the leverage of the load on the hook, and, as a consequence, the width and depth of the

latter. Further, these calculations assume the load to be central, that is, on the vertical line passing through the center of the opening. If the hook is inclined and the load is farther than this from the rear of the hook, its leverage will be increased. The dimensions of the first three hooks have been given for comparison; the last will meet the conditions with a trunnion length of 6 inches and very limited clearance.

The dimensions in Table III have been calculated for cast steel trunnions and hooks of hammered steel, using a working stress for the latter of 15,000 pounds. With the trunnion lengths given these hooks would serve.

#### Maximum Stress in Crane Hooks

The dangerous section of a crane hook is that cut from the back by a plane passed horizontally through the center of the opening; and the maximum stress in that section occurs at the point nearest the center of the hook. The width  $m$  of the entrance to the opening is usually three-fourths the diameter of the latter, and should be just great enough to pass readily the rope, chain, or trunnion which the hook is to engage. Therefore, this width determines the radius  $r$  of the opening. If the load is central, its eccentricity or leverage is the horizontal distance from the center of the opening to the center of gravity of the dangerous section. Since this leverage should be as low as possible, the radius  $r$  should be as small and the inner side of that section (trapezoidal) as wide as practicable, in order to bring the center of gravity of the

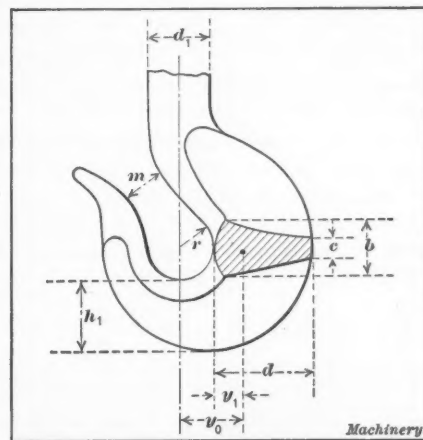


Fig. 2. Diagram of Crane Hook showing Required Dimensions

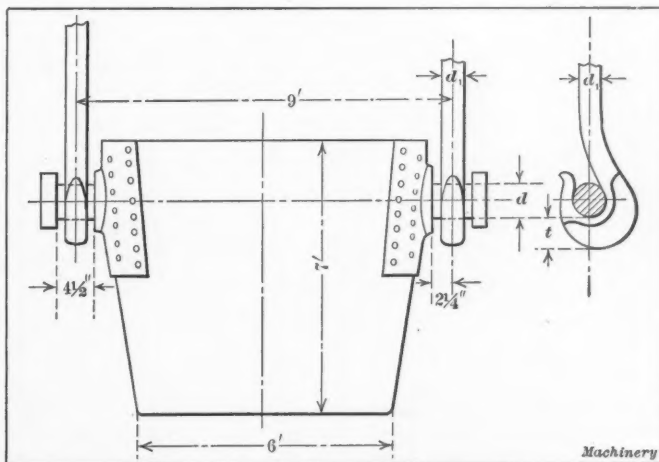


Fig. 3. Crane Ladle for which Dimensions of Trunnions and Crane Hooks are required

section as near as may be to the center of the opening. Until within a comparatively recent period, there has been no accurate theoretical analysis of the relations of these various dimensions. As a consequence, designers have been compelled to trust to formulas based partly on rational and partly on empirical grounds. Experience gained in practice has necessarily been the main reliance, since theory has supplied only the principles governing the action of an eccentric load on a straight bar.

In recent years the true stresses in a curved bar have been analyzed by Prof. C. Bach, of Stuttgart, and more completely by Prof. Karl Pearson\* and E. S. Andrews of London University. Practical tests for the investigation of the truth of the theory of Pearson and Andrews have been made by Prof. John Goodman† of the University of Leeds and by Prof.

\* "Theory of the Stresses in Crane and Coupling Hooks." Published by Dulau & Co., London.

† Proceedings of Institution of Civil Engineers, Vol. CLXVII.

Walter Rautenstrauch\* of Columbia University. In testing a crane hook, the width  $m$ —as marked in Fig. 2—of the entrance to the opening of the unloaded hook is first measured with the utmost possible accuracy. Then, gradually increasing loads are applied to, and removed from, the hook. Between each of these successive loadings the dimension  $m$  is measured. Finally, a limit is reached at which it is found that the measurement taken does not coincide with that of the unloaded hook, that is, that the point of the hook has not sprung back to its original position after the removal

TABLE II. DIMENSIONS OF THIRTY-TON CAST STEEL CRANE HOOKS

Working stress = 10,000 pounds per square inch								
Trunnions		r	m	d	b	c	d <sub>1</sub>	h <sub>1</sub>
Length, Inches	Diameter, Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
4½	5½	3½	5½	8½	5½	1½	4½	6½
5	5½	3½	5½	8½	5½	1½	4½	6½
5½	5½	3½	5½	8½	5½	1½	4½	6½
6	5½	3½	5½	8½	5½	1½	4½	6½

of the load, and hence that permanent set has occurred, the last load applied having exceeded the elastic limit of the metal at the point of maximum stress in the dangerous section. In the investigations noted above, there was found a marked agreement between the elastic limits of the hooks tested, as shown by actual loads in the testing machine and as computed from the Pearson-Andrews formula. Prof. Rautenstrauch gives the results presented in Table IV for hooks received from a number of manufacturers.

This table shows, in most cases, a practical agreement between this theoretical elastic limit and that given by test. For the larger hooks, with one exception, it indicates also that, for their rated capacity, the factor of safety is absent—a result which is due unquestionably to the use of a formula for the stress in a straight bar as the fundamental basis of their design. These tests and those of Prof. Goodman were made about four years ago, and progressive makers have doubtless considered them in their designs. It appears, then, that the Pearson-Andrews analysis, the application of the theory of the stresses in a straight bar to those in a

TABLE III. DIMENSIONS OF THIRTY-TON HAMMERED STEEL CRANE HOOKS

Working stress = 15,000 pounds per square inch								
Trunnions		r	m	d	b	c	d <sub>1</sub>	h <sub>1</sub>
Length, Inches	Diameter, Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
5	5½	3½	5½	7½	4½	1½	3½	5½
5½	5½	3½	5½	7½	4½	1½	3½	5½

curved bar, like a crane hook, will give inaccurate results, the magnitude of the error increasing with the curvature of the bar. This error seems to be due mainly to the assumption of a uniform distribution of the stress due to tension, while, on the contrary, the theory shows that the intensity of this stress is relatively great at the inner side of the section and decreases rapidly toward the outer, being analogous in this respect, as Prof. Goodman has pointed out, to the stresses in a thick cylinder subjected to internal fluid pressure. This increase in the tension at the point of maximum stress would account largely for the reduction in the assumed factors of safety of the old method. While this theory has been criticised somewhat adversely by a few authorities, the results of the tests cited above make it advisable to test the dangerous section of the proposed hook by the Pearson-Andrews formula:

$$S_t = \frac{W}{A} \left\{ \frac{y_o}{R_1 F_1} \left[ \frac{1}{\left(1 - \frac{y_1}{R_1}\right)^{\frac{2}{3}}} - F_1 \right] + 1 \right\}$$

\* Transactions of American Society of Mechanical Engineers, Vol. XXXI.

Referring to Fig. 2, the notation in the preceding formula is as follows:

- $S_t$  = tensile stress, in pounds per square inch, at point of maximum strain in the cross-section;  
 $W$  = load on hook in pounds;  
 $A$  = area of cross-section in square inches;  
 $y_o$  = distance from load line to center of gravity of cross-section;  
 $R$  = radius of gyration of cross-section;  
 $R_1$  = radius of curvature at center of gravity of cross-section. Usually in hooks,  $R_1 = y_o$ .  
 $y_1$  = distance from center of gravity of cross-section to point of maximum tensile stress;  
 $F_1$  = a function whose value, for the usual hook sections,

$$\text{Prof. Goodman gives as } \frac{R y_1}{1.2 R_1^2};$$

$F_1$  = a function whose value Prof. Goodman gives similarly as  $1 + 1.1 F_2$ .

This formula is more tedious than difficult in its application. For example, take the hammered-steel hook for a trunnion 5½ inches in diameter, whose dimensions are given in Table III. For this hook,  $r = 3½$  inches,  $d = 7 7/16$  inches,  $b = 4 15/16$  inches, and  $c = 1½$  inch. For simplicity, neglect the curvature of the inner and outer sides of the section of the hook, although in designing, this curvature should be carefully considered. Neglecting it, we have:

$$A = d(b + c) \div 2 = 24.4 \text{ square inches.}$$

$$W \div A = 60,000 \div 24.4 = 2459$$

$$y_1 = d(b + 2c) \div 3(b + c) = 3.1 \text{ inches.}$$

$$y_o = y_1 + r = 6.85 \text{ inches}$$

$$R = \sqrt{\frac{d^2}{18} \times \frac{(b^2 + 4bc + c^2)}{(b + c)^2}} = 2.04$$

Taking  $R_1 = y_o$ :

$$F_2 = (R y_1) \div 1.2 y_o^2 = 0.11$$

$$F_1 = 1 + 1.1 F_2 = 1.121$$

$$y_o \div R_1 F_2 = y_o \div y_o F_2 = 1 \div F_2 = 9.1$$

$$1 - y_1 \div R_1 = 1 - y_1 \div y_o = 0.54$$

$$(0.54)^3 = 0.1601$$

$$\sqrt[4]{0.1601} = 0.46 = (0.54)^{\frac{1}{2}}$$

Substituting the required values in the formula, we have

$$S_t = 2459 \left\{ 9.1 \left[ \frac{1}{0.46} - 1.121 \right] + 1 \right\}$$

= 25,955 pounds per square inch.

The Pearson-Andrews formula thus gives a maximum tensile stress which is 73 per cent greater than the

TABLE IV. TESTS OF CRANE HOOKS—LOADS AT ELASTIC LIMIT IN POUNDS

Rated Capacity, Tons	Material	Capacity by Test, Pounds	Capacity by Pearson-Andrews Formula, Pounds
30	Cast steel	56,000	55,080
20	Cast steel	30,000	29,925
15	Cast steel	48,000	50,750
15	Wrought iron	16,000	15,000
10	Cast steel	18,000	16,500
10	Wrought iron	16,000	15,000
5	Cast steel	18,000	18,950
5	Wrought iron	14,000	14,100
3	Cast steel	8500	8600
2	Cast steel	4700	4400

working stress used in designing this hook. This maximum stress is, however, for the designed load, well within the elastic limit of the metal, which should be at least 50,000 pounds. With a suitable factor of safety, the formulas used in this case for the tabulated dimensions of hooks will give sufficient strength.

\* \* \*

Gas flames are used to burn the fuzz from the thread or yarn used in knitting stockings. The yarn is passed through the flame at the rate of 300 feet a minute. The singeing process makes the yarn soft and silky, giving the stockings a smoother and more highly finished appearance than would be possible without it.

# NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS  
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

## DETRICK & HARVEY PLANER

The accompanying illustrations show a large open-side planer built by the Detrick & Harvey Machine Co., Baltimore, Md. Reference to these illustrations will show that the machine is equipped with an auxiliary housing by means of which it may be converted into a planer of the usual form. Fig. 1 shows the machine equipped as an open-side planer; and in Fig. 2, the auxiliary housing is shown set up in place, this illustration showing the machine operating as a standard planer. A good idea of the arrangement of the drive will be obtained by referring to the side view of the machine shown in Fig. 3. The capacity is for work up to 96 inches high by 132 inches wide between the housings, and work up to 24

The planer bed is a massive casting with two V-ways and a flat way at the center. The bed has six longitudinal vertical ribs which extend the full length of the bed under the ways; these ribs are tied together at short intervals by double web girths of box section. The distance between centers of the V-ways is 70 inches. A bearing 40 by 102 inches in size is finished on the bed and the main housing is tongued and bolted to this bearing. The bed for the auxiliary housing is bolted to the side of the bed of the machine, and the upper surface of this auxiliary bed is brought exactly parallel with the ways. It is fitted with T-slots to which the housing is secured. The table is of the box type. The upper surface is carefully machined and the guides are fitted to the ways in such a manner that the table is always maintained per-

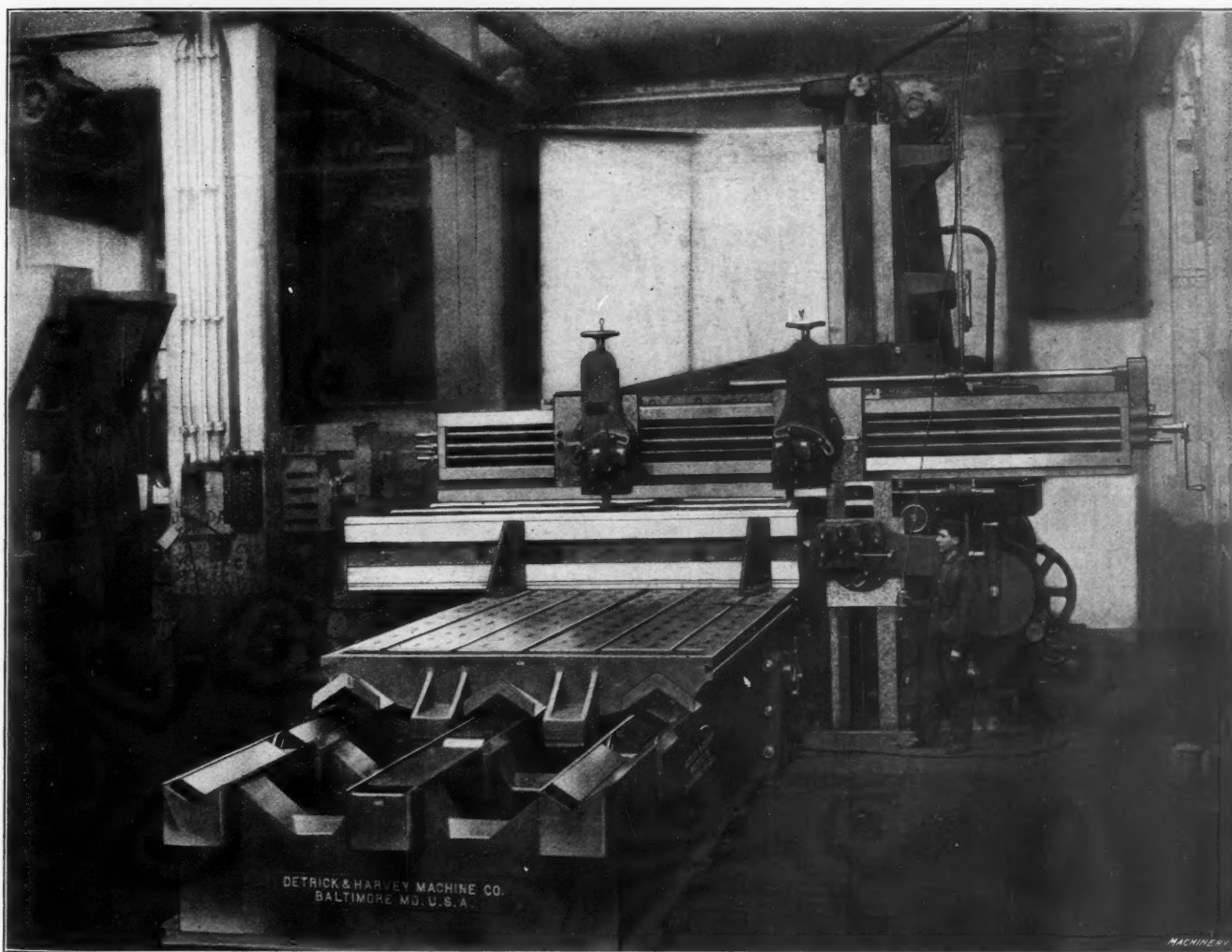


Fig. 1. Detrick & Harvey Convertible Planer, with Auxiliary Housing removed for Use as an Open-side Planer

feet in length can be handled. When the auxiliary housing at the left-hand side of the machine is removed, the cross-rail is run back in its housing and the machine operated as a standard open-side planer. Operated under these conditions, the capacity is for work 96 inches high by 96 inches wide, and up to 24 feet in length.

The table is direct connected to the motor without the use of belting. The motor is of the reversing planer type and equipped with a contactor panel and master switch, two field rheostats, the necessary grid resistance and a pendant switch and circuit breaker. The cutting and return speeds may be independently adjusted. A 220-volt direct-current motor is used for raising and lowering the cross-rail. This motor is equipped with a reversing controller, a panel with a double throw switch and a contactor connected to the controller, so that the controller handle may be turned to the "off position" before the motor can be started after the failure of the voltage.

fectly level. T-slots and cored openings are provided for holding the work. The table is so constructed that chips are prevented from dropping into the openings in the bed. The table is driven by two forged steel driving racks, each of which has a face width of 9 inches. The reversing stops can be quickly adjusted to give any desired travel up to 24 feet.

The main housing is of rectangular box section and provided with suitable connections for attaching the cross-rail housing and its braces. The auxiliary housing which carries the outer end of the cross-rail is of curved box section. It is possible to slide this auxiliary housing to and from the planer bed through a distance of 36 inches, this adjustment being made by hand. When the cross-rail and ties to the main housing are run clear, it is possible to remove the auxiliary housing without difficulty, in order to enable the machine to carry work of more than 132 inches in width. The cross-rail housing is attached to the main housing by

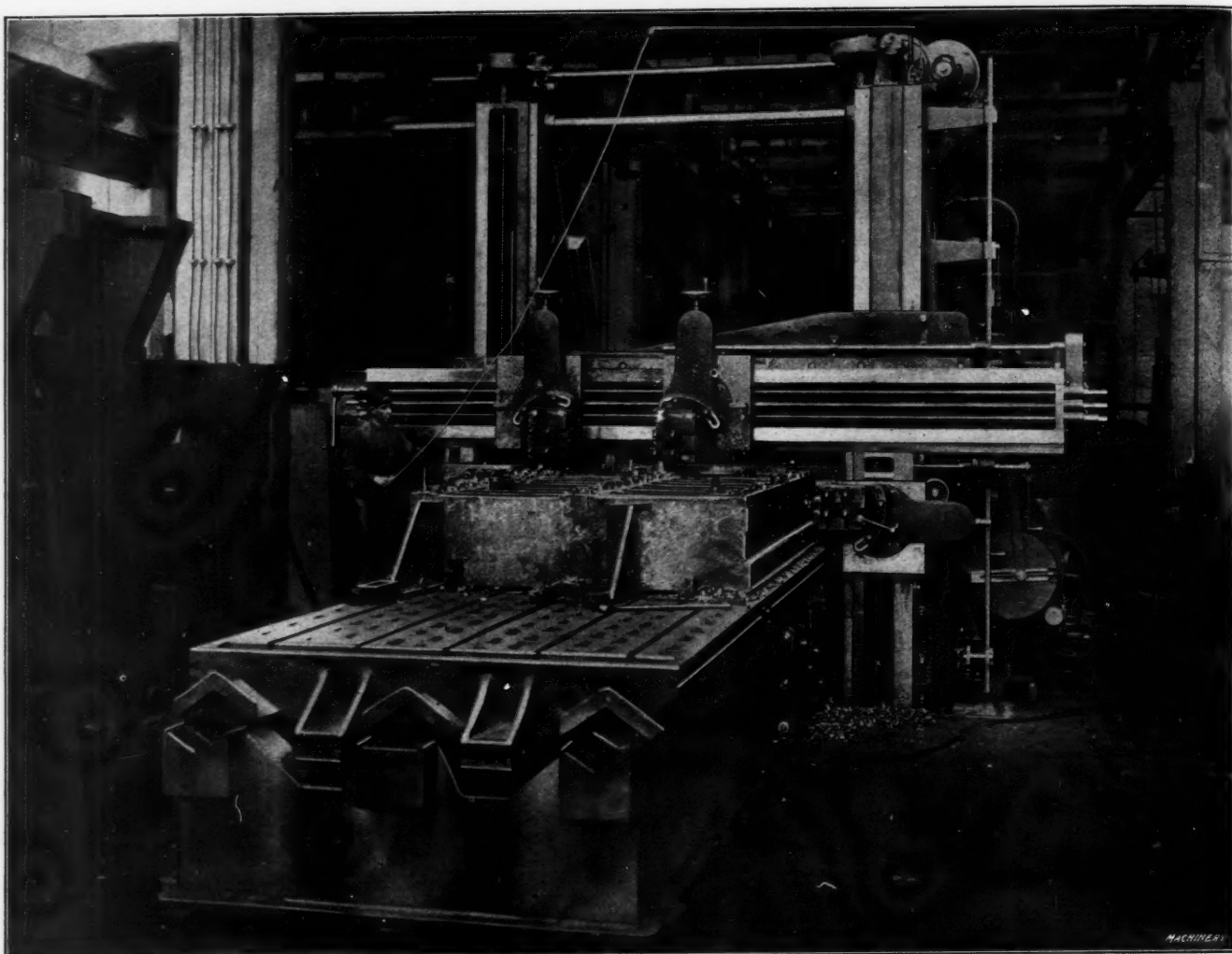


Fig. 2. Machine with Auxiliary Housing in Place, converting it into the Equivalent of a Standard Planer

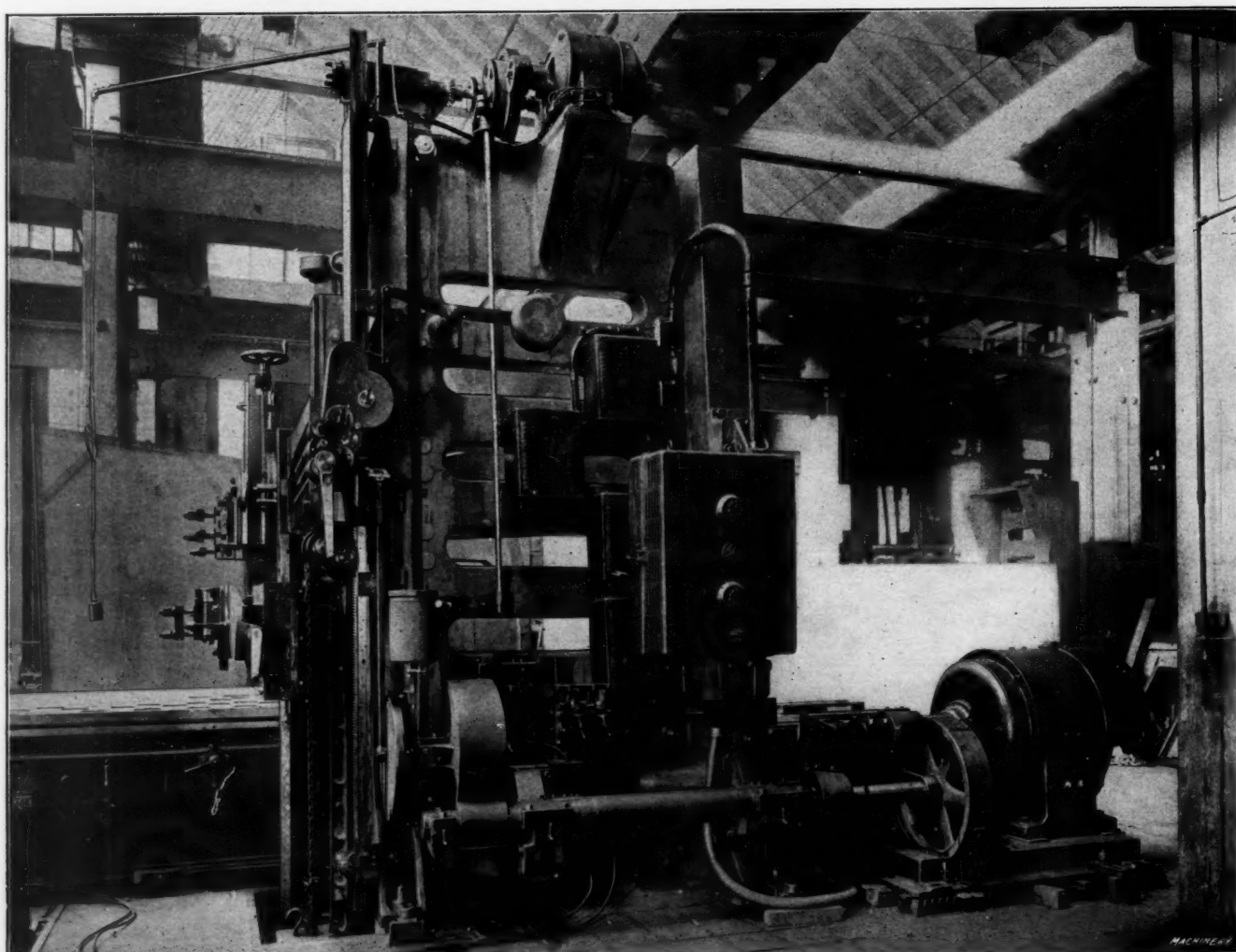


Fig. 3. Side View of Convertible Planer shown in Figs. 1 and 2 illustrating Arrangement of Drive

one vertical leg. This housing carries the cross-rail on its upper or horizontal leg. The vertical leg has a bearing of 12½ feet on the main housing, to which it is bolted. This vertical leg is faced to carry one of the side heads. The cross-rail is braced at the rear by a triangular casting extending back to the inner face of the main housing.

The cross-rail has a sliding fit in the housing to which it can be securely clamped in any desired position. It has a face width of 24¼ inches and carries two tool heads. The cross-rail can be run back through its housing by hand to clear the outer housing, when it is desired to operate the planer as an open-side machine. Four tool heads may be used, two of which are mounted on the cross-rail and one on each of the vertical housings. The heads on the cross-rail are equipped with independent automatic feed in all directions. The heads weigh about 1800 pounds each. The side heads have a vertical feed by hand or power of 96 inches with a horizontal adjustment of 22 inches. These heads are counterbalanced. The four heads are so arranged that they can be used simultaneously on work of any width which comes within the capacity of the machine.

The reversing motor is coupled to a shaft that is geared to two driving shafts. Each driving shaft is provided with a phosphor-bronze spiral pinion 21 inches long that engages a forged steel rack which is rigidly secured to the under side of the table. The steel bevel gears have a face width of 8 inches, and the face of the steel spur gears is 6 inches. The cutting speed is from 20 to 30 feet per minute and the maximum return speed, 60 feet per minute. The cross-rail is raised and lowered by screws geared to the smaller motor provided for this purpose. This motor also furnishes the power for the tool-head feeds through a positive friction device which only consumes power when feeding. The traverse of the cross-rail is obtained by screws driven by hand. The table, cross-rail and tool heads are equipped with suitable stops to prevent over-running. All of the gearing used in the machine is of steel or bronze and the control apparatus is located within easy reach of the operator.

This planer was subjected to careful tests in the manufacturer's shops before being shipped. A box-shaped steel casting about 3 feet square and 12 feet long was planed on three sides simultaneously. The four tools took the maximum cut with the maximum feed that is obtainable with modern high-speed steel. A finishing cut was then taken on the three sides and when calipered, the finished width of the casting did not vary more than 0.001 inch. The test piece was then turned over and finished on what had formerly been the under side. After completing this operation, the piece was again calipered, and it was found that the finished height did not vary more than 0.001 inch. These operations were conducted with the auxiliary housing in place, and after they were completed, this housing was removed and the same test conducted with the machine operated as an open-side planer. The results obtained were equally satisfactory.

### "AMERICAN" HEAVY SERVICE SHAPER

The working efficiency of any shaper depends primarily upon its ability to perform all classes of work at the highest speeds and coarsest feeds practicable, and at the same time to produce a finished product of dependable accuracy. To obtain these results a shaper must combine ample power, rigidity and a suitable range of cutting speeds and feeds, with a high standard of workmanship. Therefore, the relative or comparative value of a machine of this type must be determined by a careful consideration of these features, both individually and collectively, the ultimate decision being given in favor of the machine in which these points are developed to the highest degree. When designing the new "American" heavy service shaper, these conditions were borne constantly in mind by the American Tool Works Co., Cincinnati Ohio, with the consequent result that the objectionable features of former designs have been superseded by new features of proven efficiency. The workmanship is of the same high standard that has characterized this company's products in the past, a complete system of jigs and templates

being used, which insures accuracy of the highest standard, as well as the absolute interchangeability of parts. The limit of error allowed is only 0.001 inch up to the full capacity of the machine.

#### Power

One of the first points considered when laying out this new shaper was that of power input. The approximate power a shaper of this size would require for performing the heaviest classes of work was determined, and then sufficient extra power was added to provide a safe working margin. Consequently, this machine is provided with greater power than will ever be required for the average heavy work, and when doing such work it will not be constantly working up to the limit of its capacity. Before deciding on the stroke range, a very thorough investigation was made to determine the proper cutting speeds for metals of various kinds and lengths. As a result of this investigation, a range of eight strokes from 6.5 to 90 feet per minute was provided, this range being in geometrical progression and calculated to give the best results on all classes of work. It will be interesting to note here that while a wider range could easily have been furnished, it was found that a slower speed than 6.5 feet per minute is entirely unnecessary and a faster one than 90 feet per minute impracticable, on account of the excessive vibration caused by the rapid stroke and the undue wear on the machine. Therefore, by confining this range to productive limits a closer speed increment is obtained, which, in turn, gives the machine a higher working efficiency. The length of stroke may be easily changed at will without stopping the machine, the device for positioning the stroke being located on the ram near the head; and it may be operated while the machine is running. A pointer on the ram traveling along an index shows the length of stroke as set.

#### The Ram and Rocker Arm

The ram and rocker arm are of an improved design, which provides a very rigid and efficient construction. The rocker arm is rigidly connected to a pivot shaft at the bottom of the column, which supports all the weight of the arm and other parts, thus relieving the ram from any dead weight and eliminating undue vibration. The connection between the rocker arm and ram is by means of a double link which is arranged so as to pull down on the ram during the cutting stroke, thus tending to neutralize the upward thrust of the tool. The rocker arm is made in a complete U-section for its entire length and is further strengthened by heavy transverse and cross ribbing. The ram is very heavy and is designed for uniform rigidity throughout its entire length of stroke. It is thoroughly braced by internal ribs, and has long wide bearings on the column with a continuous taper gib having end screw adjustment for taking up the wear.

One of the most vital features of this shaper, and one which is absolutely essential to the life and accuracy of the machine, is the use of full length taper gibs for taking up the wear. These gibs are arranged for end screw adjustment, by means of which a perfect full length bearing can be constantly maintained and the rate of wear kept down to a minimum. The importance of this feature cannot be over-estimated, for the rate of depreciation of a machine tool is directly proportionate to the rate of wear in its bearings. The full length taper gib undoubtedly affords a more efficient and convenient method of taking up wear than is provided with flat gibs, which require the use of a series of set-screws for adjustment. Full length metal-to-metal contact is impossible with the latter type of gib. Moreover, it is also very difficult to make the necessary adjustment. With this full length taper gib construction, the original degree of accuracy can be retained throughout the life of the machine, and a full length metal-to-metal contact is assured at all times.

#### The Cross Feed

The cross feed is both automatic and variable, providing a nicely graded range of thirty-two graduated feeds from 0.006 to 0.200 inch per stroke of the ram. Feeds can be changed and accurately set while the machine is running, by means of a conveniently located knurled knob. The feed is thrown in or out, and also reversed through a knob on the feed plunger. The reversal of the feed at the opposite end of the

ram stroke is accomplished by a plunger in the face of the swinging gear on the bonnet. This plunger engages either one of two holes in opposite sides of the gear. Whether the feed takes place at the beginning or end of the stroke depends upon which hole is engaged by the plunger. All parts of the feed mechanism are compact and present a neat and symmetrical appearance; and all of the gears in this mechanism are securely covered. An automatic safety device is provided, the connection between the feed mechanism and cross-feed screw being made by means of a fiber adjustable friction. This forms a "fool proof" feature which will protect the feed works from damage should the tool accidentally be fed into the cut, or the apron be fed into either end of the cross-rail. This fiber friction can be adjusted to

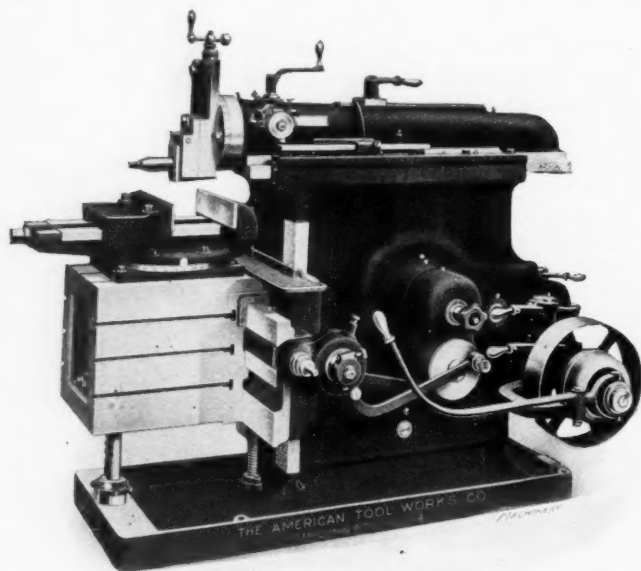


Fig. 1. Front View of American Heavy Service Shaper

pull the heaviest cut without slippage and it is not affected by atmospheric conditions, temperature, or the action of oil.

In order that the unusual power of this shaper may be utilized to advantage, every part of the machine has been designed to afford the greatest rigidity and to easily withstand the severe stresses that the use of this high power would impose upon the various parts. The column is unusually deep and wide, tapering slightly toward the top and giving the machine a neat, graceful and substantial appearance. It is strongly braced internally, the braces being so disposed as to meet the heaviest strains. The column is further reinforced outside on the line of strain, by a wide, deep rib cast integral with the wall. The top of the column projects at the front and rear and provides an exceptionally long bearing for the ram. The base is of large proportions, very deep and strongly ribbed, affording an excellent foundation for the machine. It is of the extension type, with a pad at the end to receive the table support. It is of pan construction both inside and out to catch oil drippings, thus protecting the floor and foundation. Means are provided for draining off the oil collected on the inside.

#### The Table

The table is made in a complete box section, and is therefore not liable to spring or deflect when heavy work is bolted on its side. The T-slots are all planed from the solid; and the side slots are set in the horizontal plane, thus obviating the possibility of the work bolted to the side dropping down on the base when the clamping bolts are loosened. The top of the table extends over and bears upon the top of the apron, thus increasing its rigidity and preventing dirt from working down between the table and saddle. This construction also removes the strain from the clamping bolts and, at the same time, adds a considerable amount of working surface to the table. In order to further safeguard the bearings of the rail and column, a dirt guard of pan construction is fastened to the rail, which catches chips and dirt that might otherwise work into the bearings. Felt wipers are provided on both ends of the saddle which remove the dirt and chips from the

top of the rail, and at the same time lubricate the surface. This table is firmly fitted to the apron by means of five bolts, three at the top and two at the bottom. The rigidity of this connection is further materially increased by two dowel pins extending through the top of the table into the saddle. These pins permanently locate the table in its proper position on the saddle, and also greatly increase its rigidity by preventing vibration under a cut.

The cross rail is of box form, very heavy and strongly ribbed, and of exceptional length, which gives the table a long horizontal range of travel. Three extra wide bearings for the apron are provided, which insure rigidity at that point. The rail is bolted to the column by clamps and bolts of improved design, which prevent its dropping away when the binder bolts are loosened. A stationary elevating screw of large diameter is provided, a ball thrust bearing being used on the elevating nut to facilitate the elevation of the rail. This screw enables the machine to be set on a concrete or other floor without requiring a hole to be bored through to accommodate the travel of the screw.

The head is operative at any angle within an arc of 100 degrees and has a convenient and efficient locking device. The down slide is fitted with a continuous taper gib having an end screw adjustment for taking up wear. The down feed is of unusual length, the feed-screw having an adjustable graduated collar, reading in 0.001 inch. A large tool-post is supplied for using holders with inserted bits and has a tool-steel toolpost screw and tool-steel serrated back plate. The table support furnished with this shaper represents quite a radical departure from established practice. It consists of a notched bar supplied with an adjustable nut at the bottom, and is operative throughout the full traverse of the rail. The notches are spaced one inch apart and are engaged by a spring plunger after the rail has been properly adjusted, any further adjustment necessary being accomplished through the nut at the bottom of the notched bar which bears on the planed surface of the base. This support is rigid and positive and provides the further advantage of relieving the

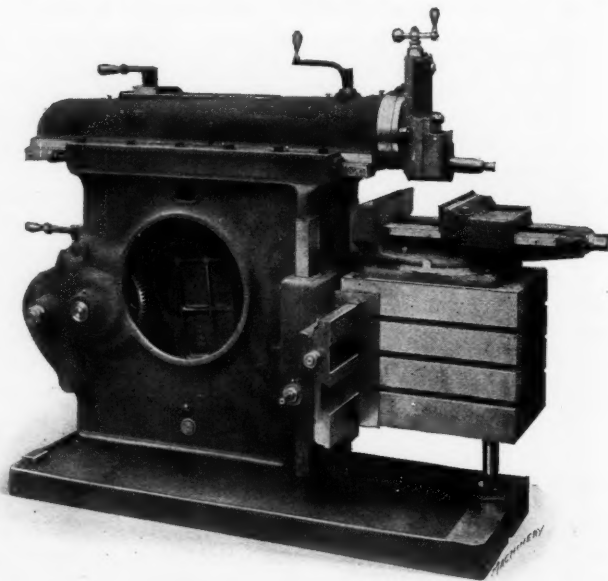


Fig. 2. Opposite Side of Machine shown in Fig. 1

rail of the weight of the table and work, thus insuring a high degree of accuracy in the work produced and less wear on the bearings.

#### Keyseating Capacity

The rocker arm is made with a double section at the top, which in connection with the large opening through the column permits a shaft four inches in diameter to be passed under the ram for keyseating. Larger shafts may be keyseated by setting over the table to allow the shaft to pass outside of the column, using the head set on an angle. The vise is of a heavy pattern and the jaws are deep and wide. They are faced with steel and provide an unusually large opening. The vise is clamped by four bolts to the swivel base, which is graduated in degrees, the latter being exceptionally large, covering nearly the entire area of the table

top to which it is clamped by four bolts. The vise screw has a bearing at both ends and is always in tension when holding the work.

#### Method of Lubrication

Special attention has been paid to the thorough lubrication of all working parts, thereby insuring long life and satisfactory service from the machine. The ram slides are oiled by means of a gravity system, oil reservoirs being provided in the ram and clamps from which felt wipers take their supply of oil and distribute it through grooves to the extreme ends of the slides, thus doing away with a multiplicity of oil holes. The felt wipers also effectually strain the lubricant, thus insuring clean oil at all times. The ram slides are provided with felt wipers at the front of the column, assisting in perfect lubrication and also preventing oil from dripping down over the front of the machine. A large quantity of oil is stored in a pocket cast integral with the rocker arm, which, with suitable means for distribution, insures thorough lubrication of the crank-pin and sliding block in the rocker arm. A felt strip inserted in the crank-pin journal insures constant lubrication.

The material used throughout is said to be of the best obtainable for the purpose used. All gears are cut from the solid with special cutters, each gear being cut with a separate cutter especially adapted to the number of teeth in the gear. This method insures a quiet running machine with a minimum of wear on the gears. The pinions are all made of

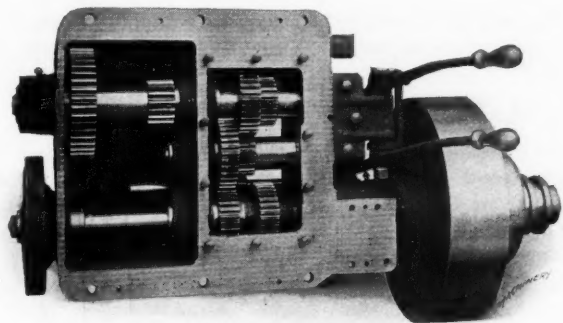


Fig. 3. Gear-box Unit for Machine with Single Pulley Drive

bar steel and the bevel pinions are planed from the solid steel. All shafts are made of crucible steel and accurately ground, and all running bearings are bushed, thus providing for easy renewal in case of wear. The bearings for the driving pulley and bull wheel are very massive and are cast integral with the column. The cone pulley is supported by a large steel sleeve which eliminates all belt pull from the driving shaft. This sleeve is provided with an efficient automatic oiling arrangement which supplies a continuous flow of oil through the journals. The steel bushing is very long, extending well into the pulley and eliminating the necessity of an outboard bearing.

#### The Speed Box

The speed box was designed especially for use on the "American" heavy service shaper. As shown in Fig. 3, it is a complete unit which is absolutely and quickly interchangeable with the cone pulley drive unit; consequently, a cone pulley driven shaper can be readily converted to speed box drive without any complications whatever, and *vice versa*. This unit is located in its proper position on the column by means of dowel pins and is held firmly in place by ten large bolts. The speed box drive provides four changes of speed, which, combined with the back-gear drive, produces a total of eight different cutting speeds for the ram. The speed changes in the box are accomplished while the machine is running, by means of seven heat-treated steel gears, the teeth of which are machine-rounded to facilitate meshing, and two operating levers which are located so that the operator can handle them without effort.

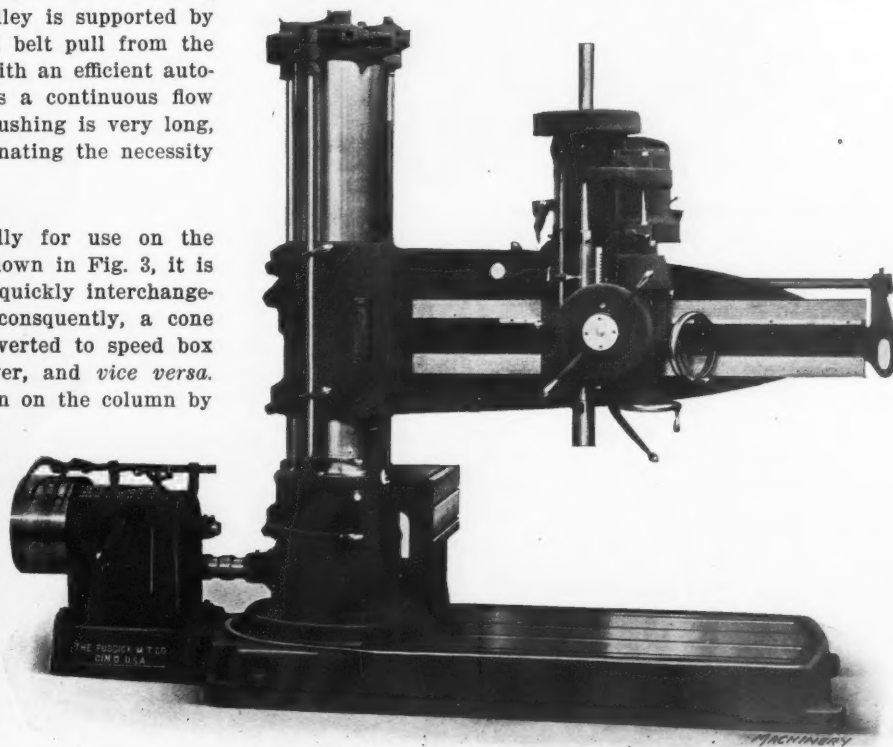
One of the features of this mechanism

that should certainly appeal to the operator is the fact that there is not a loose running part in the whole speed box. Every gear is tight on its shaft; consequently, the oiling troubles common to practically all other mechanisms of this kind are absolutely eliminated. All shafts are of crucible steel; they are of large diameter and given a large center bearing which materially increases their rigidity and reduces the overhang of the gears. All shaft bearings are phosphor-bronze bushed and are oiled by means of an efficient gravity oiling system. A recessed bushing is used which forms a retainer for the oil, which, in turn, is fed to the bearing by means of a strip of felt placed in a slot cut lengthwise in the bushing. This felt not only filters the lubricant, but regulates its flow and prevents it from running out and being wasted. A return oil groove cut in the bushing also tends to keep the oil circulating to and fro in the bearing, thus preventing its escape. To further insure the efficiency of this mechanism, it has been designed so as to be oil-tight in order to permit the transmission to run in oil. Thus a very quiet and long lived drive is provided.

A long friction lever, extending well to the front of the machine for operating convenience, controls a large diameter friction incorporated in the driving pulley, by means of which the machine can be started or stopped instantly. Acting in unison with the friction clutch is a friction brake located on the opposite side of the box, which stops the ram instantly when the friction clutch is thrown out. The countershaft has tight and loose pulleys 14 inches in diameter by 3 3/4 inches face width for cone drive, and 14 inches in diameter by 5 inches face width for speed box drive. The regular equipment includes a vise, countershaft, all the necessary wrenches and an automatic safety stop. This shaper can be equipped with power down feed, a circular attachment, a mold maker's vise and table, a tilting top for the box table, a universal table with a tilting side, a four-speed gear box and electric motor drive when so desired.

### FOSDICK HEAVY RADIAL DRILL

In the August, 1913, number of MACHINERY, the three-foot heavy radial drill made by the Fosdick Machine Tool Co., Cincinnati, Ohio, was illustrated and described. Since that time, this company has added to its line a 5-foot machine of similar design which is illustrated herewith. To provide for handling the lubricant for heavy drilling and tapping operations in steel, a liberal oil channel is cast around the base. This channel extends completely around the column and



Fosdick 5-foot Heavy Radial Drill

drains into a reservoir of ample proportions. This construction provides for the full ribbed cross-section at a point immediately in front of the column where the greatest rigidity is required; and it also allows the T-slots to extend back beyond the front of the column, thus making the full working surface of the base available.

Another feature of the machine is the table which is also provided with oil channels draining into a pocket at one corner. This arrangement eliminates the necessity of employing a pump and piping. The column is of the double tubular type with a fixed inner column extending to the top. The arm is of pipe and beam section designed in such a way as to give the maximum resistance to torsional and bending strains. The clamping levers are located at the front where they are convenient for the operator. The head is easily run along the arm by means of a compound ball bearing spiral gear. The feed box is placed low on the head, giving support to both sides of the worm, which is mounted on a ball thrust bearing and runs in oil. All feed changes are made with a single lever.

### DIAMOND MOTOR-DRIVEN SURFACE GRINDERS

The Diamond Machine Co., Providence, R. I., has recently re-designed its line of automatic surface grinders. The construction of the machines has been improved in many ways, although the general design and method of operation remains essentially the same. One important change has been made,

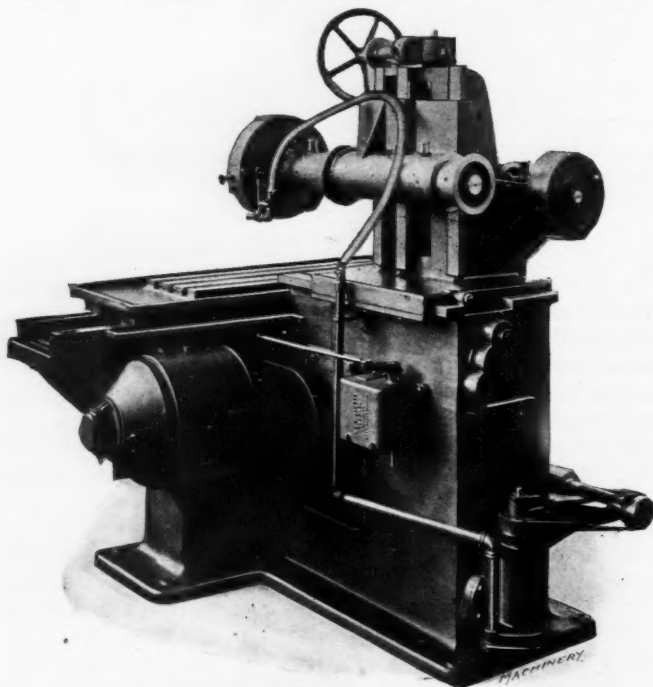


Fig. 1. Diamond Motor-driven Surface Grinding Machine

however, i. e., the application of electric motor drive on machines of this type. It will be seen from the illustrations that the motor drive eliminates the use of countershafts and overhead belting. Either direct or alternating-current motors can be used.

Two motors are employed which are of a special type developed for the Diamond Machine Co. One of these is a 2-horsepower constant speed motor running at 1200 revolutions per minute; and the other, a  $\frac{1}{2}$ -horsepower, high resistance frame, specially wound reversing motor which runs at 600 revolutions per minute. The 2-horsepower motor drives the spindle and the  $\frac{1}{2}$ -horsepower motor is for the table. Controllers for both motors are mounted at the front of the grinder. The spindle drive is accomplished by belting from a drum fastened to the motor shaft direct to the pulley on the driving shaft of the machine. The belt is kept tight by an idler. The remainder of the transmission is the same as on belt-driven machines, power being transmitted from the driving shaft to the spindle by a second belt. The table is driven by the reversing motor through a cloth pinion which

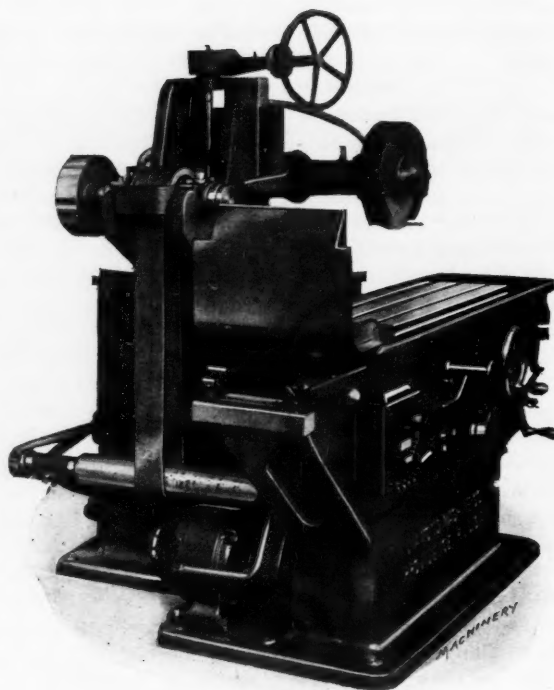


Fig. 2. Opposite Side of Machine shown in Fig. 1 transmits power through an idler gear and bronze pinion to a gear on the feed pulley shaft.

### HARRINGTON "UNDER" MILLING MACHINE

The style B "under" milling machine built by the Harrington Machine Co., Erie, Pa., is shown in the accompanying illustrations. This machine is especially designed for milling drop-forging dies and for other classes of irregular open work. A taper cutter is used to give the die the desired clearance in all directions, and as the cutter is on the bottom or under side of the work, the term "under milling machine" has been applied.

The table is provided with movable chucking jaws which are tongued into grooves in the table. They may be removed and clamps used for securing larger work than comes within the capacity of the chuck jaws. The longitudinal and traverse travel is obtained by square threaded screws fitting in bronze nuts. Adjustment for wear is provided so that lost motion can always be taken up. The spindle is of high-carbon steel with the seat for the collet hardened and ground. It runs in three bronze bearings which are made adjustable

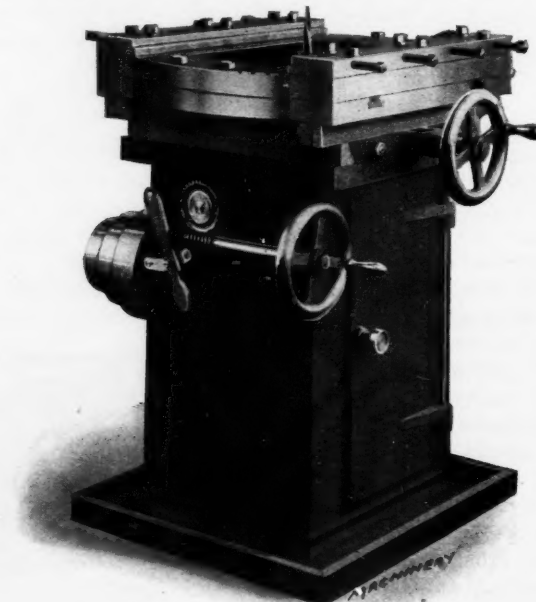


Fig. 1. Harrington "Under" Type of Milling Machine for Die Work

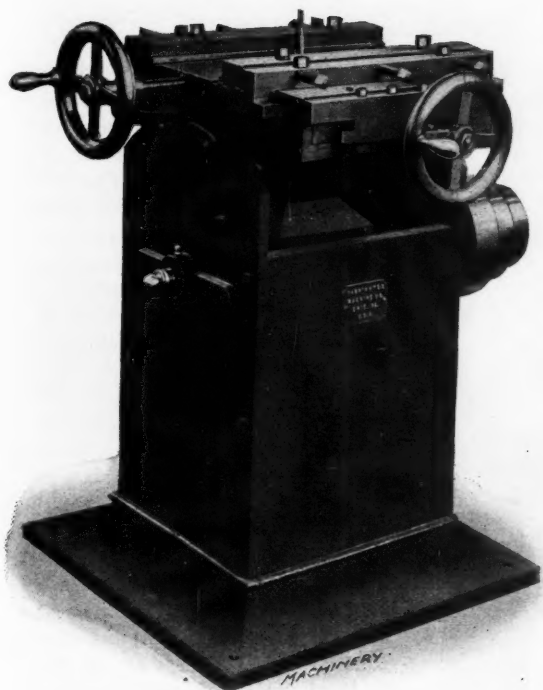


Fig. 2. Opposite Side of Machine shown in Fig. 1

for wear, and is driven by bevel gears which transmit power from a three-step cone pulley. The gearing is completely encased to exclude dirt and chips. The capacity is for cutters  $1 \frac{3}{16}$  to  $1 \frac{3}{8}$  inch in size. The table can be raised to use the small part of the cutter for milling sharp corners. The longitudinal traverse is 14 inches and the transverse traverse is 7 inches. The rotary table top enables angle lines to be followed. The floor space occupied is  $42 \frac{1}{2}$  by  $44 \frac{1}{2}$  inches, and the weight of the machine and countershaft 1920 pounds.

### BARNES DRILLING AND TAPPING MACHINE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now building a 20-inch all-g geared drilling and tapping machine which is provided with a self-oiling system. The all-

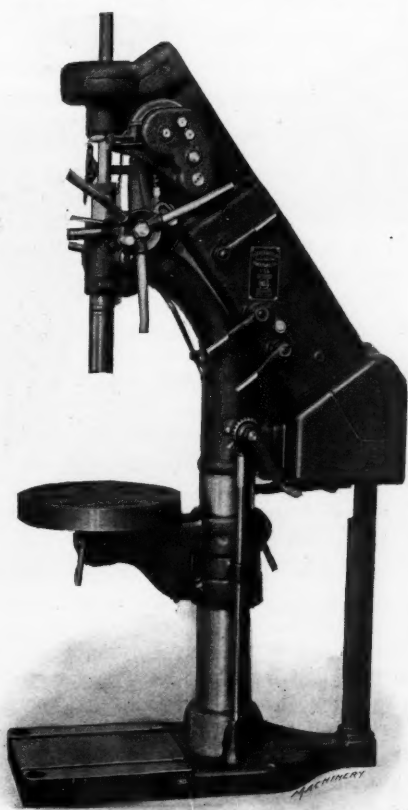


Fig. 1. Barnes 20-inch All-g geared Drilling and Tapping Machine

geared feature provides for building a machine of heavy construction, with exceptionally high power for its swing. This combination of high power with the self-oiling feature, makes a machine of unusually high efficiency. Every bearing, with the exception of the spindle sleeve, is self-oiling and there are eight changes of geared speed and eight changes of geared feed, all of which are under instant control of the operator from the front of the machine. All gears are fully enclosed, thus meeting the requirements of modern safety laws. The capacity of the machine is for high-speed twist drills from  $\frac{1}{4}$  to  $1 \frac{1}{4}$  inch and these drills may be driven to their maximum capacity.

The machine is equipped with back gears and automatic stop for the geared feeds, and the same machine is also built without back gears. Reversing friction clutch gears and automatic reverse may also be provided when so desired. Both types of machines can be equipped with motor drive and for fast high-speed drilling with drills less than 1 inch in diameter, special crown gearing is provided to double the spindle speeds. The oil for the self-oiling system is delivered by a geared pump which draws the lubricant from the reservoir of the machine and distributes it to all gears and



Fig. 2. Opposite Side of Machine shown in Fig. 1

bearings, including the crown gears and gears in the feed box. This self-oiling system is used by the Barnes Drill Co. under license from the Kearney & Trecker Co., of Milwaukee, Wis.

It will be seen from the illustrations that the frame of the drill is of unusual design and that it is of exceptionally massive construction. The spindle is made of machinery steel, double splined and ground to size; it is fitted with a special ball thrust bearing. The spindle is counterbalanced and the nose is extended to bring the drift hole below the sleeve. The graduations on the sleeve are in inches and millimeters. The gears for the speed changes are located on the diagonal shafts; they are cut from special chrome nickel steel bar stock and tempered, the stock used for this purpose having a tensile strength of 270,000 pounds per square inch. The eight changes of speed—four of which are obtained without the back-gears—may be easily and quickly obtained without requiring the drill to be stopped. These changes are made by simply operating the proper shifting lever, which is within easy reach of the operator when standing at the front of the machine. The back-gears are operated by a small lever which is also accessible from the front

of the machine, and may be instantly engaged or disengaged while the machine is running.

Either of the eight changes of geared feed may also be obtained while the spindle is running idle by placing the index lever in the proper notch on the segment. The feeds are indicated in plain figures so that there should be no danger of mistake. A safety device prevents overloading and reduces the chance of breaking the drill. The star-wheel lever which controls the hand feed is entirely different from

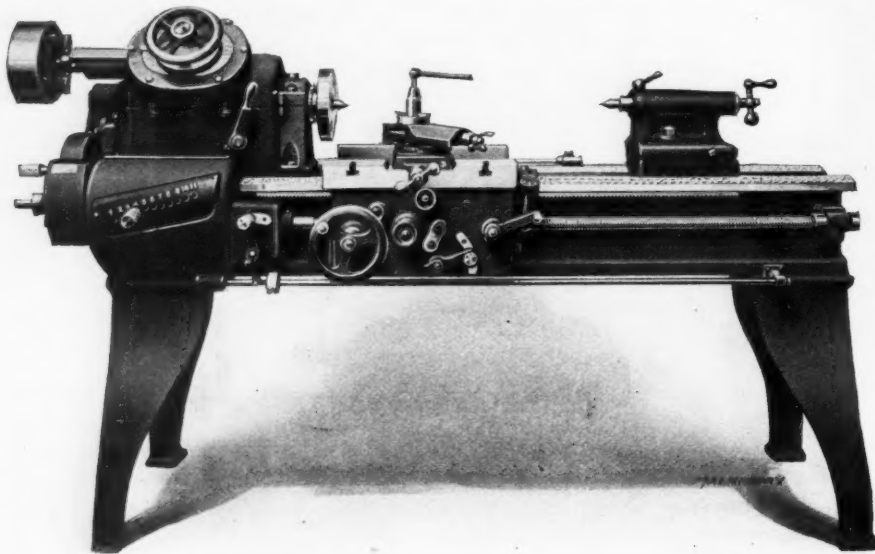


Fig. 1. Carroll-Jamieson 14-inch Tool-room and Manufacturing Lathe

the common ratchet lever. It operates through a pinion meshing with an internal gear, the ratio being 4 to 1. This makes the star-wheel handle equivalent to a common lever of four times its length. The star-wheel also acts as a quick return lever, thus eliminating the necessity for using a ball handle for this purpose. The machine is usually equipped with a round table but a square table with an oil channel can be substituted. The table is raised and lowered by a crank which operates the elevating screw through bevel gears. The table can be swung around on the column and clamped in any position. The machine has an automatic reversing mechanism which is a very desirable feature.

For tapping operations, the friction clutch gears give reverse speeds of  $1\frac{1}{4}$  to 1 and these gears are located at the driving end of the machine instead of on the spindle. As the machine is geared down to 13 to 1 in front of the clutch gears, this eliminates the excessive wear and tear which would result if the clutches were placed directly on the spindle. The machine has an automatic reversing mechanism for depth tapping. The trip can be set so that when the tap has reached any required depth, the spindle is automatically reversed, thus backing out the tap at an increased speed. The shifting lever can also be set so that when the machine is tripped—either automatically or by hand—it will return to the neutral position, thus stopping the spindle instead of reversing it. The small hand trip lever shown in the illustration is always ready for instant use if it is desired to reverse the machine or stop the spindle at any point in the operation. When the machine is to be motor-driven, a 2-horsepower motor running at about 1200 revolutions per minute is recommended for use on this 20-inch drill. This arrangement possesses the well-known advantages of individual motor drive.

## CARROLL-JAMIESON LATHES

The Carroll-Jamieson Machine Tool Co., 257 Davis St., Batavia, Ohio, is now building the 14-inch tool-room and manufacturing lathe illustrated in Fig. 1; and also the 13-inch back-geared screw cutting lathe shown in Fig. 2. The name of the first machine referred to indicates the scope of work for which it is intended, while the 13-inch screw cutting lathe was particularly designed to meet the requirements of auto-

mobile repairing and general machine shop practice. A careful study of the requirements of this class of work showed the designers of this machine that it was necessary to provide a heavy, rigid construction to stand up under the varied classes of work for which a tool is used in service of this nature. Having made this brief introductory statement, the features of the two lathes will be taken up in some detail. The 14-inch lathe shown in Fig. 1 is equipped with a selective sliding gear mechanism and single pulley drive. The head is absolutely oil-tight and dust-proof and the gearing runs in an oil bath. All of the gearing in the head is cut from high-grade steel blanks and then heat-treated and hardened. The driving pulley runs in an extended bronze bushing which relieves the driving shaft of strain and undue wear. The handwheel at the top of the head controls eight changes of speed and the back-gears are engaged by means of the

vertical lever seen immediately below and to the right of the handwheel.

The geared head was particularly designed to facilitate rapid production. It has already been mentioned that the handwheel on the head provides for obtaining either of eight changes of speed; these speeds are in geometrical progression and the change can be made instantly while the machine is running at its highest rate of speed. The arrangement of the gears by which these speed changes are obtained is shown

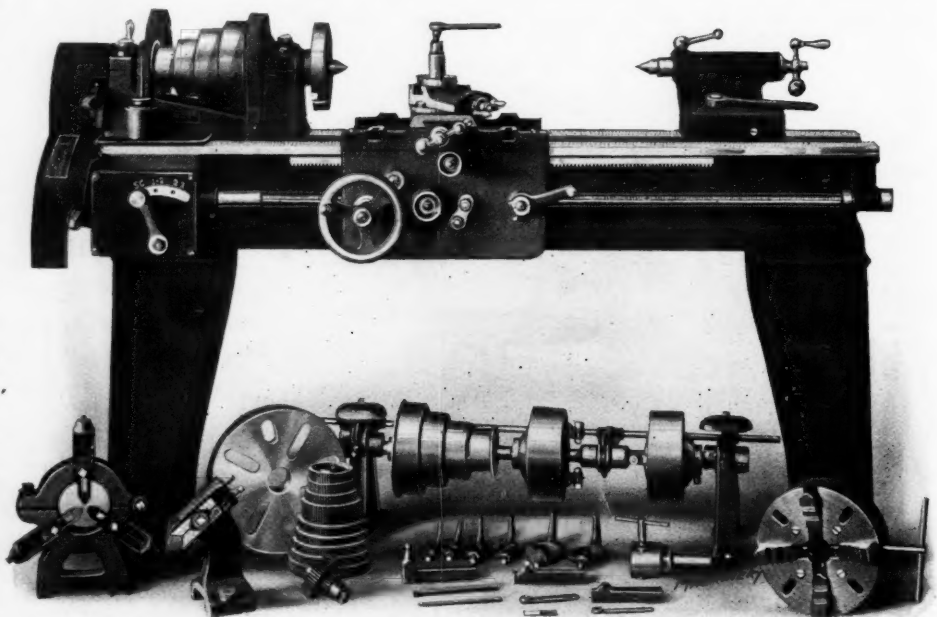


Fig. 2. Carroll-Jamieson 13-inch Back-geared Screw-cutting Lathe

in Fig. 3. The main driving gear stops automatically when the handwheel is pulled forward and it is impossible for any two speeds to be engaged at the same time. The gears in the head have short, stub teeth; the spindle is made of special hammered crucible steel and is finished by grinding. The bearings are bushed with a special hard bronze and scraped to an accurate fit; and provision is made to compensate for wear. The head is substantially ribbed to secure the necessary rigidity and all bearings are self-oiled. The quick-

change gear mechanism is of simple construction and provides for cutting threads from 3 to 64 per inch including all standard and odd threads as well as  $11\frac{1}{2}$  pipe threads. Reverse is provided in the head as well as the apron. Fig. 4 shows the arrangement of the back gears and the lever for throwing them in or out of engagement. All bearings in the apron which carry moving shafts are bronze bushed. The alignment of the spindle is accurate to 0.0005 inch in 12

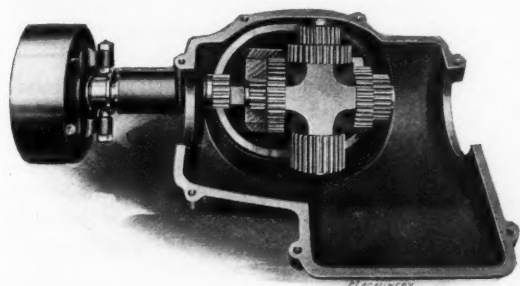


Fig. 3. Arrangement of Speed Change Gears on 14-inch Lathe

inches and the error in boring and turning operations will not exceed 0.001 inch in 12 inches.

The head of the 13-inch back-gear lathe shown in Fig. 2 is fitted with a hardened steel spindle which is accurately ground to size. The spindle runs in chilled cast-iron bearings which are scraped to an accurate fit. The error in the alignment of the spindle does not exceed 0.001 inch in 12 inches. It will be seen that the machine is driven by a 4-step cone pulley which is arranged to carry a 2-inch belt. The machine is back-gear in the ratio of 7 to 1. The tailstock is of the cutaway pattern, permitting the compound rest to be swung around to an angle of 90 degrees. It is fitted with a  $1\frac{11}{16}$ -inch sleeve which is bored to No. 4 Morse taper. The tailstock can be set over for turning tapers. The carriage is gibbed at both the front and back and the cross-slide is 6 inches in width.

The cross-feed screw has the usual graduated collar reading to 0.001 inch and the compound rest is graduated to 360 degrees. The apron has power cross feed and longitudinal feed, and there are three changes of feed obtained through sliding gears which are secured by placing the lever in either of the three stations on the feed box. Change gears are provided for cutting from 5 to 36 threads per inch, including  $11\frac{1}{2}$  pipe thread. There is also one extra compound gear to cover all odd and special threads from 3 to 72 per inch. The regular equipment of the lathe consists of a large and a small faceplate, a follow-rest, a steady-rest, a compound rest, a full set of change gears and double friction countershaft.

Experience with the work that comes to the average garage shows that there is not enough large size work to warrant investing in a lathe swinging over 14 inches. The large lathe is not convenient for the general run of repair work and it is only occasionally that a job is met with which is too large to be handled on the 14-inch lathe. To meet the requirements of these occasional jobs which exceed the capacity of a lathe of this size, the Carroll-Jamieson Machine Tool Co. has designed an attachment for increasing the swing of its 13- and 14-inch lathe. Equipped in this way, the 13-inch lathe swings  $18\frac{3}{4}$  inches over the ways—which is ample for the maximum requirements of garage work—and the 14-inch lathe swings 22 inches over the ways. This attachment can be placed on a lathe as quickly as a steady-rest and will be found a very convenient equipment for the repair shop. The spindle is accurately lined and will handle boring and turning operations with a high degree of accuracy. The nose of the spindle conforms to the nose on the lathe spindle so that the same faceplates, chucks or centers can be used. The

attachment takes up 8 inches on the lathe bed. The attachment consists of head and tail piece, the compound rest, swivel block and one steel gear that fits the nose of the lathe spindle and drives the intermediate gear of the attachment. When the attachment is received it is ready to place on the lathe.

### INGERSOLL-RAND AIR COMPRESSOR

The steadily increasing use of low-grade fuel oil for power purposes has led the Ingersoll-Rand Co., 11 Broadway, New York City, to add to its line the oil engine driven air compressor, which is illustrated herewith. This unit is of the direct-connected straight line type and in this respect it is somewhat similar to the standard line of small compressors built by this company. The main frame is designed for a splash system of lubrication; it is wholly enclosed and provided with removable covers. The feature of greatest interest is the design of the driving end of the unit. This consists of a single oil engine cylinder set behind the air cylinder and direct-connected to the air piston by means of an extended piston rod. The general design follows a type known as the "hot bulb engine" which is really a development of the Diesel engine, and combines high thermal efficiency with simplicity of construction.

No auxiliary air compressors are employed and this, combined with a lower working pressure, makes an ideal equipment for compressed air service. The power cylinder is of the single-acting, two-cycle type. It is water jacketed and provided with an efficient system of lubrication. A torch is

provided for heating the ignition bulb preparatory to starting the engine, but after the compressor is well under way, the use of this torch is unnecessary. The fuel is automatically injected into the combustion chamber by means of a small pump operated by the main shaft. It enters in the form of a finely atomized spray and is immediately ignited by the hot bulb, thus dispensing with the use of an electric sparking device. The

stroke of the fuel pump is regulated by a centrifugal governor located in the flywheel; and this regulates the amount of fuel injected into the cylinder, making it proportional to the load. This method of regulation is supplemented by a regulating device on the intake of the air cylinder.

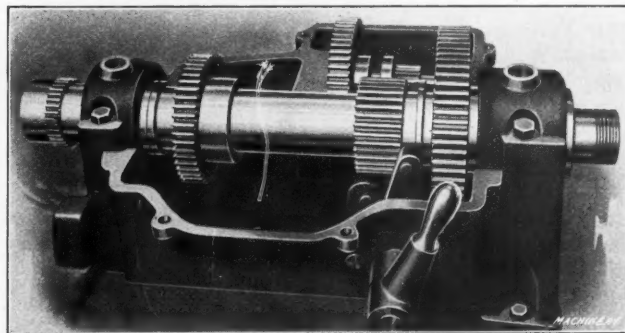


Fig. 4. Back-gears on 14-inch Lathe and Lever for throwing them into Engagement

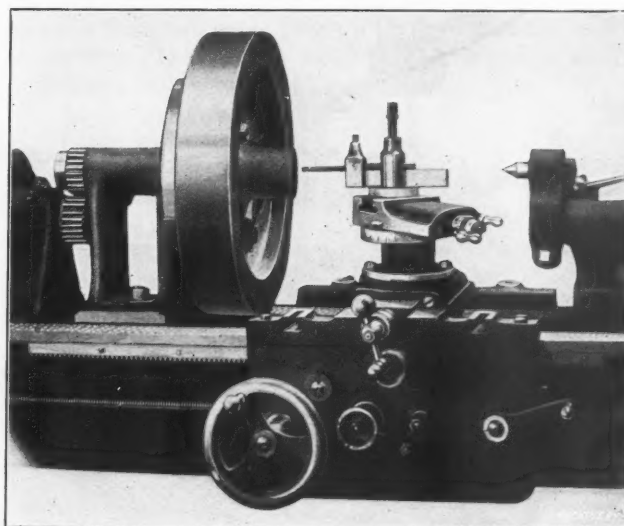
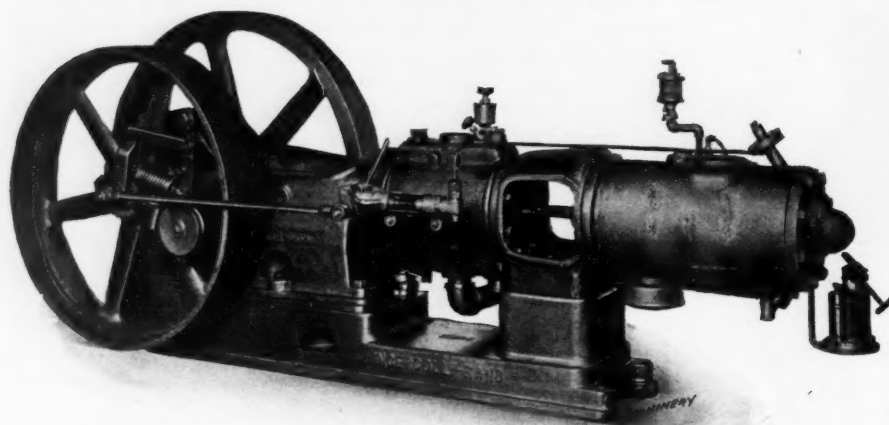


Fig. 5. Attachment for increasing the Swing of Carroll-Jamieson 13- and 14-inch Lathes

The method of operating this unit is accompanied by none of the losses common to many two-cycle gasoline engines, in which part of the incoming charge follows the exhaust gases through the outlet ports. This is due to the fact that the

fuel is not vaporized by an outside agency and introduced with the air used for "scavenging"; but is injected directly into the cylinder at the end of the compression stroke, as previously mentioned. This means that pure air is used during the scavenging period of the stroke, with the result that the inlet and outlet ports can be arranged in such a way that more thorough scavenging is effected without any loss of fuel. The absence of a carbureter with its needle valves, springs and delicate adjustments, which require constant



Ingersoll-Rand Oil Engine Driven Air Compressor

attention to suit varying atmospheric conditions is also a material advantage.

Another feature of the engine is the provision of means for inducing a small quantity of water from the cylinder jacket into the combustion chamber. This water performs the function of regulating the temperature in the cylinder, thereby preventing an undue rise in the temperature of the piston and cylinder walls, which would be liable to result in a disassociation of the fuel oil. This practice reduces the maximum pressure in the cylinder but slightly increases the mean effective pressure, making a smooth running and highly economical engine. The amount of water injected is regulated according to the load on the compressor. At present, this unit is made in but one size which has a capacity for 66 cubic feet of free air at 100 pounds pressure and 73 cubic feet at 80 pounds pressure, when running at 325 revolutions per minute. Under average operating conditions, the fuel consumed at this speed is about 2.2 gallons of kerosene per hour. The engine is adapted for the use of either kerosene, fuel oil or distillate. The unit occupies a floor space of 8 feet 10 inches by 2 feet 5 inches and the weight is 3000 pounds.

## NEWTON LOCOMOTIVE LINK GRINDING MACHINE

Front and rear views of a link grinding machine which was recently built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., for use in the Baldwin Locomotive Works, are illustrated in Figs. 1 and 2. When it was necessary for locomotive builders to grind links which were required to be hardened, the operation was the cause of considerable trouble. The nearest approach to economical production was obtained by taking a heavy planing machine, equipping the rail with a grinding spindle and mounting the link to be ground on a swiveling table which was oscillated by a guide traveling in a straight channel, the angle being adjustable to suit various radii. A brief consideration will make it evident that this method gave only approximately accurate results.

To enable this operation to be handled more efficiently, the machine which forms the subject of this article was designed and built by the Newton Machine Tool Works. This machine possesses a material advantage over the equipment referred to in the preceding paragraph, in that the table carrying the link can be adjusted for depth of cut and from side to side, without disturbing the radius control. The machine has a compound spindle slide. The smaller slide, which is at the front, has a reciprocating motion of  $\frac{5}{8}$  inch which permits of the use of large diameter grinding wheels having a face broad enough to cover the entire surface to be finished. The secondary slide has a vertical feed to permit of using small diameter wheels which are required, owing to the slight amount of clearance, and which are too small to provide the requisite strength if made the full length of the finished surface. This feed works vertically and has an automatic reverse for both directions of travel. In operation, the links are placed on pins attached to the top table which, in turn, is held parallel by pull pins at each end. The radius bracket shown in Fig. 2 is adjusted to the required location which is determined by a scale. The drive for the spindle and for the table travel are independent and can be varied to suit different requirements. The maximum capacity of the machine is for links up to 120 inches radius by 5 inches face, and the weight of the machine is 12,000 pounds. The accuracy of the work done by this machine is well up to the standard of other modern machine tools, while that of the planer attachment was merely approximate.



Fig. 1. Operating Side of the Newton Link Grinding Machine



Fig. 2. Rear View of Newton Link Grinding Machine

## STANDARD WIRE DRAWING MACHINES

A wire drawing machine which is built in four sizes by the Standard Machinery Co., Elmwood Ave., Auburn, R. I., is illustrated in Figs. 1 and 2. These machines are adapted for drawing steel and copper wire as well as wire of the precious metals, and are particularly suited for drawing steel wire from  $\frac{5}{8}$  inch down. The machine illustrated is the smallest size; it has a drum 22 inches in diameter by  $8\frac{1}{2}$  inches high, the drum operating at a lineal speed of 50 feet per minute. The "draw-out" drum which performs the preliminary operation operates at 19 feet per minute. This machine occupies a floor space of 4 feet 6 inches by 7 feet 6 inches and has an approximate weight of 4000 pounds.

It will be seen from Figs. 1 and 2 that the machine is driven by a single pulley, this pulley being provided with a friction clutch. The driving shaft is back geared to the large spur gear shown in Fig. 1. On the same shaft with this gear there is a bevel pinion which meshes with the large bevel gear on the vertical spindle that drives the drum. The machine is started by engaging the friction clutch which is controlled by the handle at the extreme left of the machine. The handle at the extreme right is for the purpose of engaging an internal clutch located inside the drum, which sets the draw-out drum in motion.

The die is supported in a holder shown at the corner of

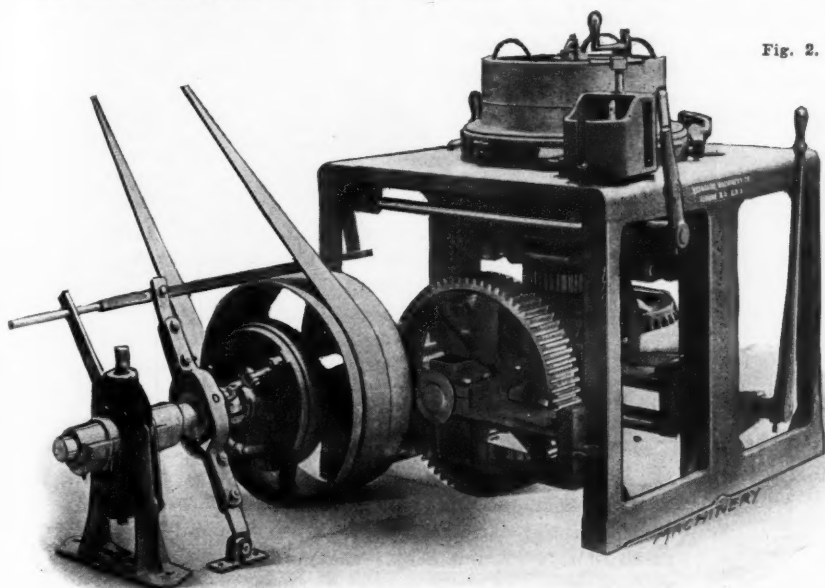


Fig. 1. Wire Drawing Machine built by the Standard Machinery Co.

the table. In preparing for a drawing operation, the stock is pointed so that it can be put through the die and have a length of 3 inches extending out to be gripped by the tongs. This pointing of the stock is done by either a hand or rotary swager or by any other suitable method, a hydraulic squeezing press being used in some cases. After the stock has been pointed and threaded through the die in this way, it is gripped by the tongs and the internal clutch is then engaged to start the draw-out drum. When the draw-out drum has made one-half revolution, the lever shown in Fig. 2 engages a trip which disengages the tongs, causing them to release their hold on the work. The machine is then stopped and the end of the wire, which has been drawn out, is brought up and clamped to the main drawing drum, after which the machine is again started and the drawing operation completed.

Various methods of lubricating the work are employed. Some use waste and silk wiper cloths saturated with oil, these being placed

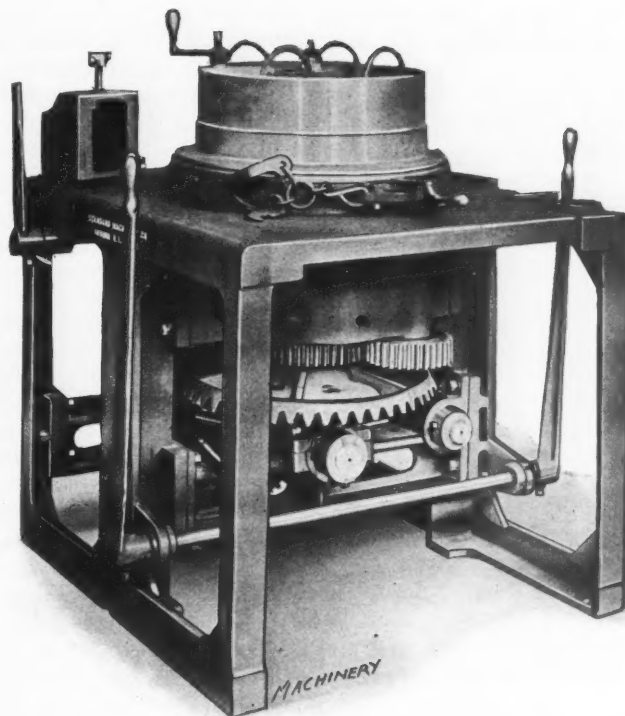


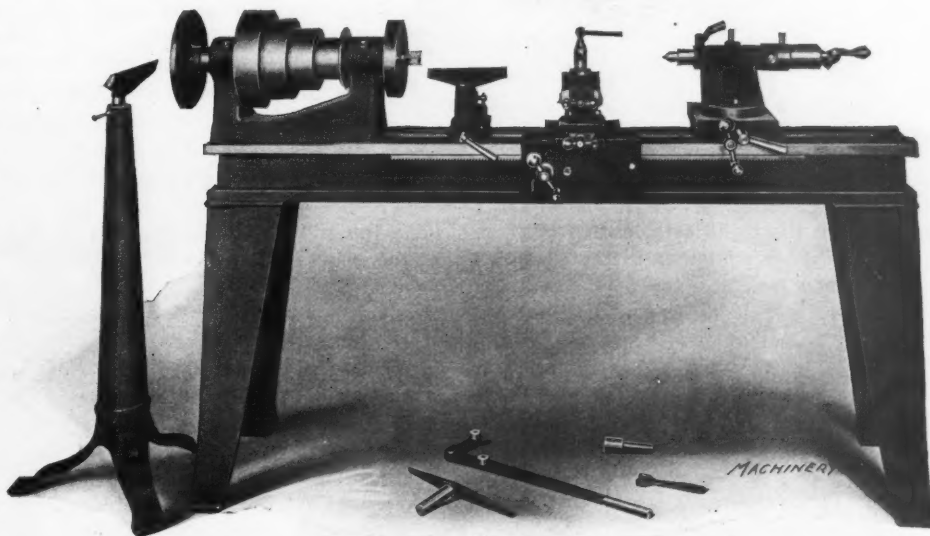
Fig. 2. Closer View of the Machine showing Arrangement of the Drawing Drums

on the work at the far side of the die and supplying the necessary lubrication. Others rub a special palm-oil soap on the wire. In some cases it is found advantageous to pass the wire through a bath of oil that is set upon the table of the machine.

## BLOUNT PATTERNMAKER'S LATHE

The patternmaker's lathe which forms the subject of this article is a recent product of the J. G. Blount Co., Everett, Mass. This machine swings 16 inches and has a bed 6 feet in length. The spindle is hollow and forged from high-carbon steel; it runs in self-oiling bronze bushed bearings. The outer end of the spindle is threaded to receive a faceplate for turning work of large diameter and the tripod rest shown at

the left-hand end of the lathe is provided for use in connection with work of this nature. In addition to the usual hand rest, the lathe is equipped with a carriage that has rack and pinion feed. The carriage has hand operated cross feed and is equipped with a compound rest.



Blount Patternmaker's Lathe and Tripod Rest for Use in connection with the Faceplate

The tailstock has screw and lever feed and is made with a graduated base so that any required taper may be bored or turned. A taper pin provides for bringing the tailstock back into alignment. The base of the tailstock is provided with a slide and the tailstock may be fed crosswise by operating a ball handle. The equipment of the lathe includes a plain countershaft with tight and loose pulleys or a friction countershaft with two friction pulleys.

### C. & E. RATCHET WRENCH

The combination ratchet and alligator wrench illustrated herewith is a recent product of the C. & E. Mfg. Co., Marshalltown, Iowa. This wrench has only three working parts and is made of drop-forged carbon steel. It is strong and not likely to get out of order. There are four different sizes of ratchet jaws provided, any of which may be put on the

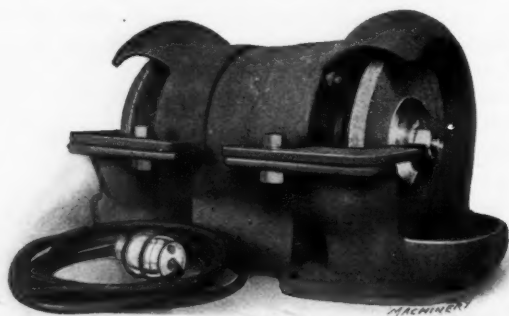


The "Marshalltown" Wrench made by the C. & E. Mfg. Co.

wrench by turning the handle through part of a revolution. The ratchet feature enables the wrench to be operated through a half revolution and is particularly convenient in removing nuts in cramped positions. The ratchet jaws have capacities of  $\frac{3}{8}$ ,  $\frac{7}{16}$ ,  $\frac{1}{2}$  and  $\frac{9}{16}$  inch, respectively.

### FORBES & MYERS BENCH GRINDERS

In the August, 1913, number of MACHINERY the polyphase grinder made by Forbes & Myers, 178 Union St., Worcester, Mass., was briefly described. In response to a demand for a lighter machine of similar type, which can be used on electric light circuits, this company has added four new models to its line. In designing these machines, particular attention has been paid to the starting current in the smaller sizes. The motor will develop a full  $\frac{1}{6}$  horsepower, but the current is small enough so that there is practically no danger of burning out the fuses when attached to a lamp socket. The construction of the rotating element is similar to that of the standard polyphase machines. The grinders are made with two forms of frame, one of which



Forbes & Myers Bench Grinder for Operation on Lighting Circuits

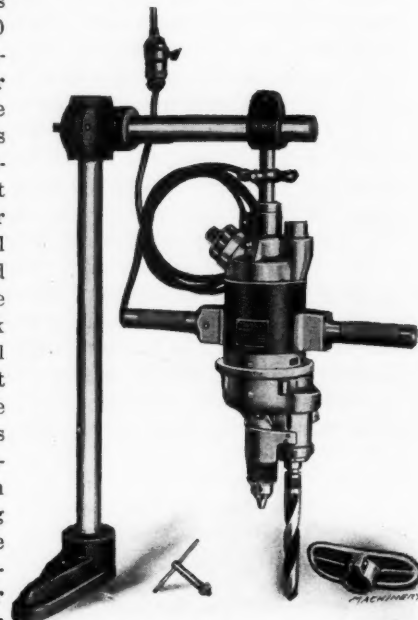
has a water basin, adjustable tool rest and wheel guards, while the other is similar with the exception that the guards do not extend over the top of the wheels. The equipment includes two wheels 6 inches in diameter by  $\frac{1}{2}$  inch face width and 10 feet of reinforced lamp cord.

The larger sized machines of this line are equipped with  $\frac{1}{2}$  horsepower motors which may also be used on a lighting circuit, although they are really larger than should ordinarily be used in this way. A simple and reliable centrifugal device is used to open the circuit of the starting winding when the motor has come up to the required speed. The grinders equipped with the  $\frac{1}{2}$  horsepower motors are also provided with wheels 6 by  $\frac{1}{2}$  inch in size, and are powerful

enough for grinding lathe and planer tools and handling a variety of other machine shop work.

### STOW TWO-SPINDLE DRILL

Stow Mfg. Co., Binghamton, N. Y., is now manufacturing the two-spindle, two-speed drill which forms the subject of this article. One of the spindles of the tool is fitted with a Jacobs chuck for handling straight shank drills up to  $\frac{1}{2}$  inch in diameter. This spindle runs at 450 revolutions per minute. The other spindle takes Morse taper shank drills up to  $\frac{3}{4}$  inch in diameter and runs at 225 revolutions per minute. The tool can also be arranged so that it is possible to remove the chuck from the small spindle and mount it in the large spindle. With this tool, the small spindle provides high speeds for driving small drills, while the large spindle provides ample power for drilling larger sized holes. The



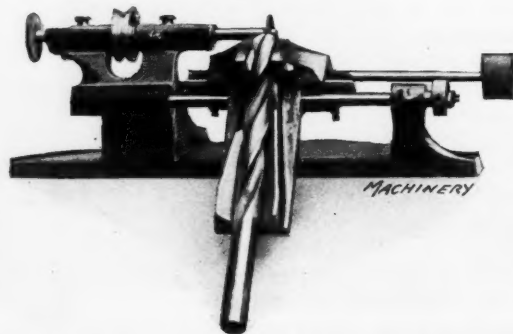
Stow Two-spindle Two-speed Drill

spindles of the tool can be easily reversed so that it can be used for tapping operations. Either direct- or alternating-current motors may be provided and the motors are suited for connection to an ordinary lighting circuit.

### MATHER TWIST DRILL SLOTTING MACHINE

E. B. Mather, 1415 Lake Ave., Rochester, N. Y., is exploiting a patented method of slotting the point of twist drills and the machine used for this purpose. The machine is shown in the accompanying illustration, and by its use a small slot is ground across the point of the drill. This is said to give the drill several important advantages over a twist drill with a point of the standard form. The drill cuts faster and it is claimed that the feed pressure and torque are materially reduced, with the result that the slotted drill operates about 50 per cent faster than a drill of standard design. It is also said that the drill will operate longer before it requires re-grinding, and that when drilling in brass there is no tendency for the drill to catch as it comes through.

Tests of these slotted drills were recently conducted in the experimental engineering laboratories of Sibley College at Cornell University. Drills  $\frac{1}{2}$ ,  $\frac{5}{16}$  and  $\frac{3}{16}$  inch in diameter were used, one set of drills being slotted and the other left plain, but neither set of drills had been previously used. The feed pressure required was determined by applying the pressure through a piston rod connected to a piston



Machine for slotting Twist Drills by the Mather Process

working in an oil cylinder. The use of a pressure gage enabled the feed pressure to be determined. The torque was determined by a spring balance used in connection with a radial arm. The results of the test showed that the slotted drills cut at a higher speed than the plain drills were capable of reaching under the same feed pressure. The power required to drive the slotted drills was somewhat greater, but the quality of the work was about the same in both cases. The torque was considerably less for the slotted drill. Another series of experiments was conducted to determine the tendency of the slotted drill to run out as compared with that of the plain drill. The results showed that the slotted drills were superior to the plain drills in this respect.

### HESS-BRIGHT BALL BEARING

The Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., has added to its line what is styled the Bright "2-RO" ball bearing which is illustrated herewith. This bearing was particularly designed for use in automobiles and for other classes of service in connection with bevel gears, where a bearing is required for carrying both thrust and radial loads.

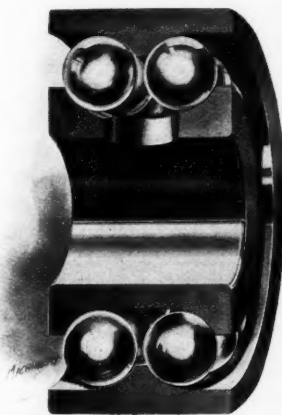


Fig. 1. The Bright "2-RO" Ball Bearing

Simplicity is the striking feature of the design of this bearing. The inner and outer races are of forms which lend themselves readily to accurate grinding. The balls are of the usual degree of accuracy found in a high-grade ball bearing and have two points of contact. The arrangement of the filling opening provides for filling the races with balls, and when the bearing is completely assembled the points of contact are so far from the filling opening that there is no danger of the balls striking the edge of it. It is stated that the location of the opening is such that it does not weaken the race.

The angle of both the thrust and radial loads, or the combination of two such loads, is such that the balls are kept away from the filling opening and this condition is further

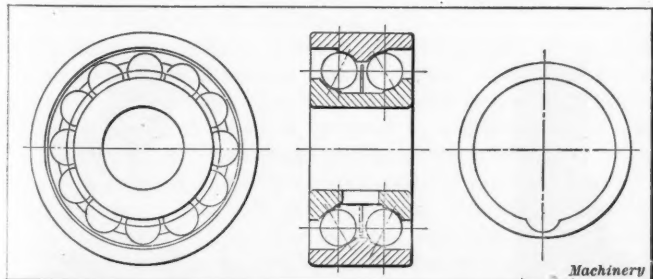


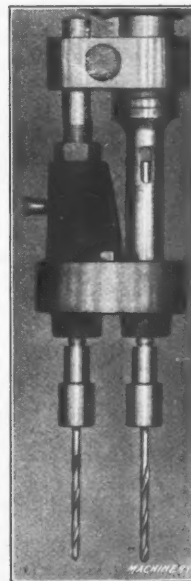
Fig. 2. Details of the Bright "2-RO" Ball Bearing

assured through the action of centrifugal force. The split inner ring is in no sense a separator; its function is to simply float between the two rows of balls and keep them away from the filling opening. It is only in unusual cases that the ring is required, as at such a time when an undersized ball stops opposite the filling opening; under normal conditions none of the balls enter the opening when the bearing comes to rest.

Assuming that the mounting is properly aligned, the bearing has a high capacity for carrying radial loads, as such loads are uniformly distributed over two rows of balls. The bearing also has a comparatively high capacity for carrying thrust loads in either direction, the thrust load either way being sustained by one full row of balls. This, of course, assumes that the mounting is properly lined up. If this condition is not fulfilled, a uniform distribution of the load will not be secured, and the bearing will not operate at its maximum efficiency.

### SELLEW TWO-SPINDLE AUXILIARY DRILL HEAD

A simple form of auxiliary drill head especially adapted for use in connection with small sized sensitive drilling machines, where a number of holes are drilled in fixed locations, is illustrated herewith. It will be seen that one of the drills is held in a spindle which has a taper shank carried in the spindle of the drilling machine. This taper shank is geared to the second spindle of the drill head. Above the driving gears there is a hub extension, and the head is clamped by a single screw in the yoke block which fits the quill of the drilling machine. Lightness and simplicity are the distinguishing features of this drill head, and its application on a machine effects a considerable increase of capacity on those classes of multiple drilling operations which come within its range. This two-spindle drill head is the latest product of the Sellew Machine Tool Co., Pawtucket, R. I.



Sellew Two-spindle Drill Head

### STEVENS TURRET TOOLPOST

Fig. 1 shows a lathe turret toolpost which is made by A. H. Stevens, 138 Thacher St., Hornell, N. Y.; and Fig. 2 shows the toolpost in use on a lathe. It will be seen that it consists of a turret which carries several tools, any one of which can be quickly brought into the operating position. The toolpost is fastened directly to the cross-slide of the lathe and may be quickly put in place or taken off. It is of compact and rigid construction. The turret is only free to revolve in one direction and is positively locked to prevent the thrust of the tool turning it.

Two simple movements of the lever are sufficient to change the position of the turret; moving the lever toward the operator revolves the turret and moving it away from him locks the turret, which is automatically located after being brought to an approximate position. The pin encased in the base is of hardened tool steel and engages a slot in the turret; there is no tendency to spring, as the turret is located

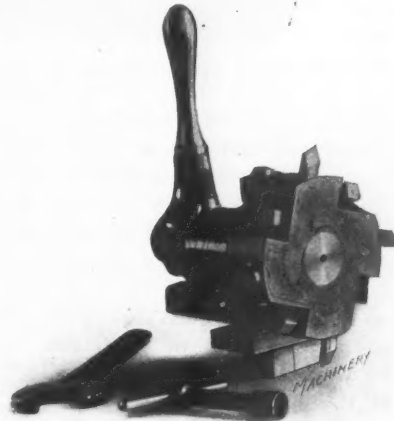


Fig. 1. Stevens Turret Toolpost

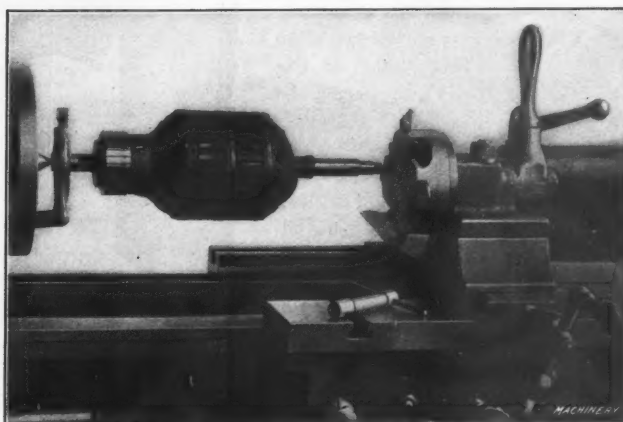


Fig. 2. Stevens Turret Toolpost in Operation on the Lathe

directly over the support. It will be evident to the reader that this toolpost is intended for machining those classes of work where several successive operations are performed, and its use saves a considerable part of the time occupied in changing tools.

### GARDNER COMBINATION PATTERN-MAKER'S MACHINE

The experience of the Gardner Machine Co., Beloit, Wis., with the disk grinding machines and roll sanding machines of its manufacture, has led to the combination of these two types of machines in a single unit. This is known as the No. 20 combination patternmaker's machine. The machine is

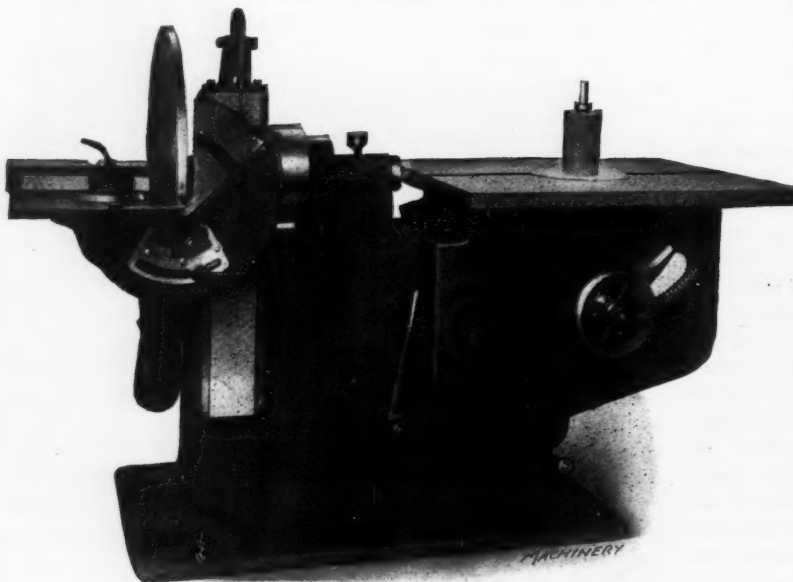


Fig. 1. Gardner Combination Disk Grinder and Roll Sander for Use in the Pattern Shop

shown in Fig. 1 with both the roll sanding spindle and adjustable work table set at right angles. Fig. 2 shows both ends of the machine in operation, and it will be noticed that in this illustration both the roll sanding spindle and the work table are shown set at an angle, in order to illustrate the adjustment which is possible. These adjustments are particularly convenient in many classes of patternmaking work where it is desired to finish surfaces at an angle with each other.

At the disk wheel end, the machine is equipped with a wheel 30 inches in diameter which runs at 950 revolutions per minute. This wheel is faced with "netbac" garnet paper which is attached to the wheel without requiring the use of an arbor press, or the wheel to be removed from the spindle in order to have a new disk applied. A universal work table is provided, which is mounted on a dovetail slide back of the cutting plane of the disk wheel. The table may be raised or lowered and instantly locked in any desired position, the use of a counterweight within the column of the machine enabling the position of the table to be adjusted without undue exertion on the part of the operator. The table is also provided with angular adjustment in relation to the face of the disk wheel, the table being shown at right angles to the wheel in Fig. 1 and set at an angle in Fig. 2. A graduated segment at

the end of the table provides for making accurate angular settings, and one turn of the handwheel locks the table in the desired position. The axis about which the table swings is so arranged that the edge remains close to the face of the disk wheel regardless of the position in which the table is set. This is a particularly advantageous feature when working on small size patterns.

There are three work gages provided for use in connection with the table. One of these is a universal angle gage which is particularly serviceable in producing patterns having compound angles and for squaring up patterns. As its name implies, the duplicating gage is used for producing duplicate pieces and for generating parallel surfaces. The circle generating gage is used in connection with the production of round shaped pieces which are usually handled on the lathe. Its use enables external arcs of various radii to be accurately produced.

The sanding roll at the opposite end of the machine is used for generating and finishing internal curves which have been roughed out on a band saw. The piece is finished complete on this machine, which does much of the work usually performed by hand carving or on the lathe, but in a fraction of the time which would be required by either of these methods. Four different diameters of rolls are provided, all of which are 7 inches in length. As the diameters vary from 2 to 6 inches, it is evident that the smaller rolls must be driven faster in order to give a suitable cutting speed. This speed variation is provided for, the range of spindle speeds available being from 2000 to 6000 revolutions per minute. The sanding rolls are made of cast aluminum and accurately balanced. They are covered with a sheet of "netbac" paper which is cut at an angle, so that the joint runs in a complete spiral around the roll instead of being on a straight line. This does away with the vibration which would be caused by having the joint

on a straight line. When the "netbac" paper on the roll becomes worn, it is merely necessary to soak the roll in water for a few minutes to soften the cement, after which the abrasive paper is peeled off and a new sheet substituted.

The roll spindle has a vertical reciprocating motion of  $\frac{1}{8}$  inch for the purpose of avoiding the production of ridges

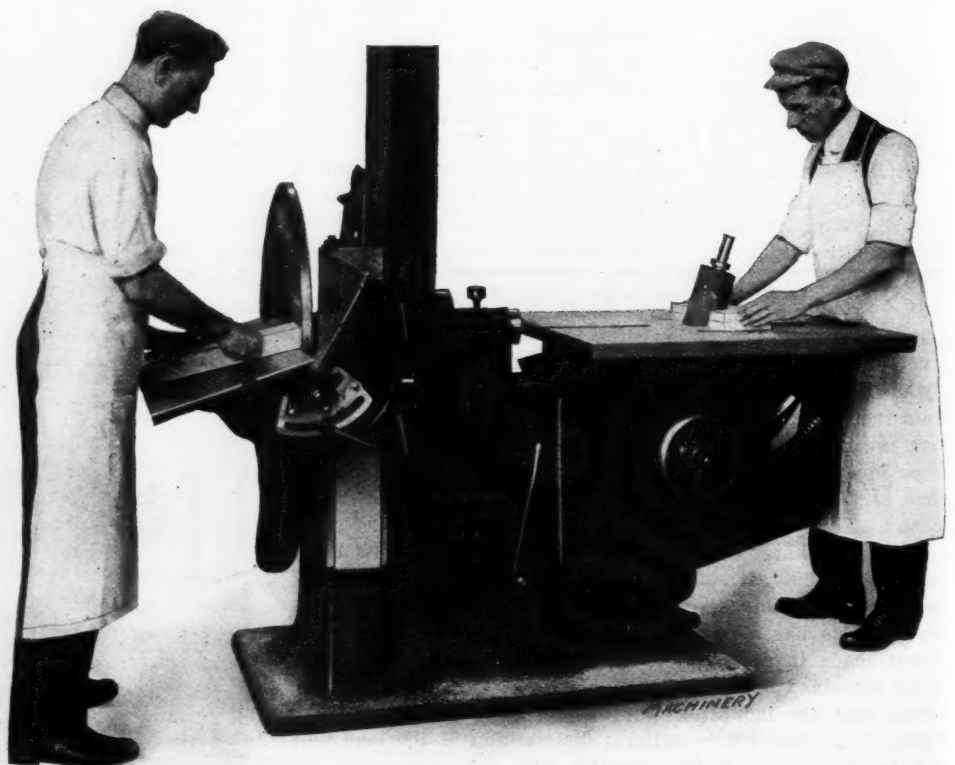


Fig. 2. Machine shown in Fig. 1 with Both Ends in Operation

in the work; this also increases the rapidity with which the roll cuts. The reciprocating motion is provided by having the roll spindle engage with a pivoted fork which works over a cam. The mechanism is positively driven by spiral gears and the entire weight of the spindle and roll is supported on a ball bearing. Another important feature of the roll end of this machine is that angular surfaces can be finished as readily as those which make an angle of 90 degrees with the table. For this purpose, the work spindle is set at the desired angle with the table rather than resorting to the alternative of setting the table at an angle with the roll spindle. The table at the roll end of the machine remains horizontal at all times. The angle to which the roll is set is accurately registered on a graduated segment which is located directly behind the locking handwheel. In shops where floor space is at a premium, this combination of two stand-

roll spindle is from 2000 to 6000 R. P. M. and the disk spindle operates at 950 R. P. M. The power required to operate the machine at its full capacity is 5 horsepower and the operating space required is approximately 6 by 12 feet. The weight of the machine is about 3000 pounds. The regular equipment furnished with the Gardner No. 20 combination pattern-maker's machine includes a 30-inch disk wheel and four aluminum sanding rolls 2, 3, 4 and 6 inches in diameter by 7 inches high; a supply of "net-bac" garnet paper disks and sanding strips; a supply of cement and grease; three work gages; a countershaft; and the necessary wrenches.

### NUTTER & BARNES CUTTING-OFF MACHINE

The 10-inch cutting-off machine illustrated in Fig. 1 is a recent addition to the line of metal cutting saws built by the Nutter & Barnes Co., Hinsdale, N. H. This saw follows the general lines of design adopted in the construction of the other types of machines built by this company. The 10-inch machine differs from the smaller sizes, however, in that the saw carriage is automatically returned after completing the cutting stroke. Other features of this machine not found on the smaller sizes are the increased size of the work table, the double set of screw clamps for securing the work, and the heavier construction of the machine to adapt it for heavier work. Aside from these features, the machine is quite similar to the Nutter & Barnes 8-inch cutting-off machine which was illustrated and described in the December, 1910, number of MACHINERY.

The introduction of fast feeds and speeds in cutting metal has made it necessary to provide easy means for handling the stock to be cut, and for supplying a liberal quantity of lubricant to keep the saw and work cool. The cutting lubricant is stored in a reservoir in the base of the machine and delivered to the saw by a geared pump. An improvement has recently been made by attaching a combination saw guard and lubricator to the end of the piping. One of these combination guards is shown in Fig. 2, from which an idea of the construction will be obtained. The guard affords protection to the operator and also does away with the danger of breaking the saw when material is being placed on the work table. As it is possible to deliver a large volume of cutting lubricant at the exact point where it is most needed, this device is the means of enabling higher speeds and feeds to be employed with a corresponding increase in production. The combined guard and lubricator is quickly adjusted to suit different sizes of saws and can be raised to clear the saw when it is desired to remove it for sharpening. A special throttle is provided for changing the direction of lubricant

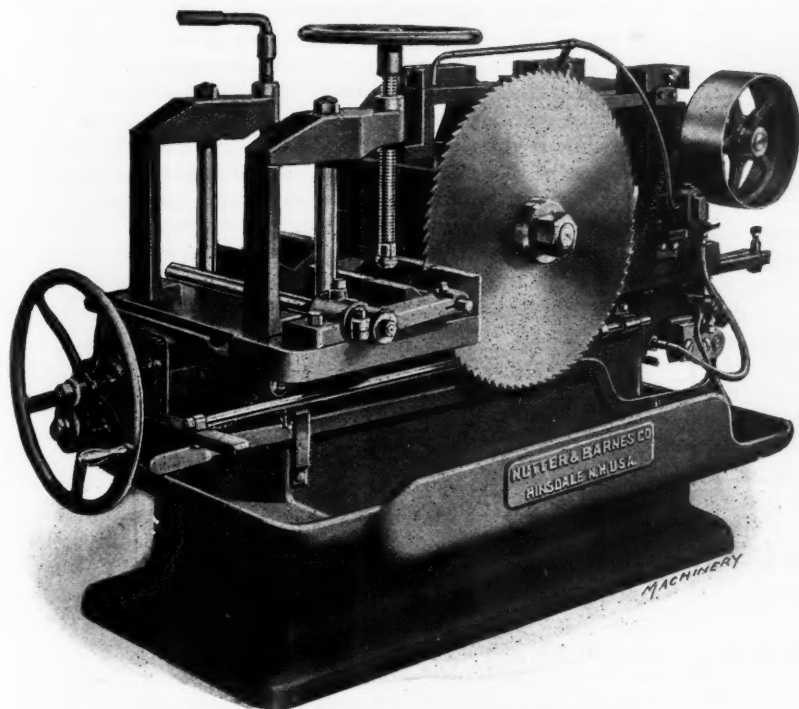


Fig. 1. Nutter & Barnes 10-inch Cutting-off Machine

and machines into a single unit effects a material saving in the room required for equipment.

If the main spindle which carries the disk wheel is in operation, the sanding roll can be started or stopped as frequently as necessary. The motion of the roll spindle is controlled by a clutch which is operated by a handle at the front of the machine. The disk wheel is provided with an efficient dust hood and the sanding roll throws but little dust into the air. When it is desired to make provision for removing the dust from the roll, the best plan is to suspend an exhaust pipe from the roll with an enlarged opening of suitable size. The driving spindle can be mounted in either babbitt lined bearings or ball bearings as required. The machine shown in the accompanying illustrations is provided with plain bearings. The machine is well adapted for direct connected motor drive and where this method of driving is employed, the motor is mounted on a bracket at the rear and connected to the main driving spindle by a silent chain. A few of the more important dimensions of the machine are as follows: The disk wheel table is 36 by 15 inches in size and the sanding roll table 31½ by 36 inches; the four sanding rolls provided for use on the machine are 2, 3, 4 and 6 inches in diameter by 7 inches in length; the speed variation of the

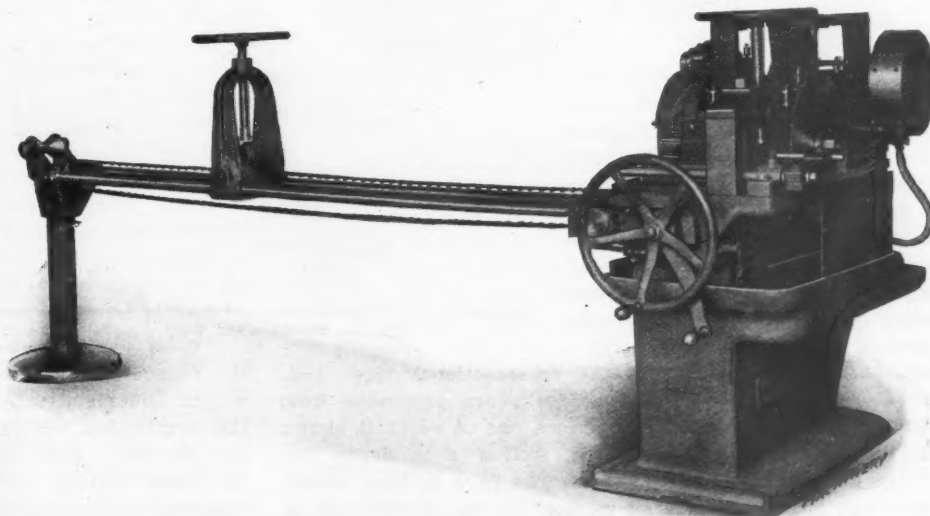


Fig. 2. Combination Guard and Lubricator for Nutter & Barnes Machines

as it is delivered to the cutting point, or for stopping the flow entirely while the machine is running.

In most cases, metal-cutting saws are employed to cut bar stock of various lengths, but the length of the work is usually great enough so that the use of an independent stock rest is necessary. The usual method of feeding the stock requires the operator to leave his machine and push or pull the bar along by hand, after each cut has been completed. Fig. 3 shows a stock feed attachment which has recently been brought out by the Nutter & Barnes Co. to provide for feeding the stock mechanically. This equipment is shown in connection with the 6-inch size cutting-off machine but may be applied to any of the machines built by this company. The device consists of a pedestal support containing an idler roll which supports the weight of the stock at the outer end. Two round bars connect this standard to the base of the machine; and the traveling stock rest or carriage in which the stock is clamped moves along these bars, the movement being controlled by a crank at the front of the machine. This crank is connected to a chain which, in turn, is attached to the stock carriage. The usual length in which this stock feed attachment is furnished is 6 feet, but the length may be easily increased by providing longer or shorter connecting bars and a chain of corresponding length. In operation, the

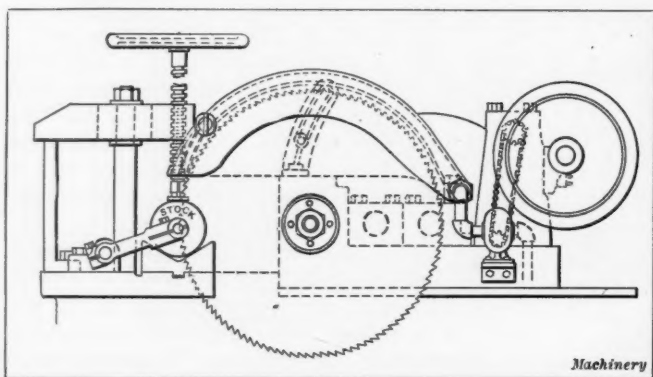


Fig. 3. Nutter & Barnes 6-inch Cutting-off Machine equipped with Stock Feed Attachment

stock clamp on the machine is released and the stock brought forward by turning the crank at the front of the machine, until the end of the bar has been brought into contact with the stock gage, which is set in accordance with the length of the piece that is required to be cut off. The clamp on the machine is again tightened and the saw started. This sequence of operations is repeated until the traveling clamp has reached the full length of its traverse, after which the clamp is released and moved back to the starting position at the opposite end of the connecting bars.

### BECKER MILLING CUTTER

A high-power inserted tooth milling cutter which has recently been placed on the market by the Becker Milling Machine Co., Hyde Park, Mass., is shown in Fig. 1; and Fig. 2 presents details of the construction of this tool. The most important feature is the solid back-rest for the cutter teeth, inserts being provided in the cutter body, against which the teeth have a solid bearing, as shown in the cross-sectional view A-A. The inserts which back up the teeth are prevented from moving in or out by means of screws, one of which is shown in the cross-section B-B. The section C-C shows one of the adjusting screws. These screws have  $\frac{5}{8}$  inch adjustment and provide for taking up wear on the cutter teeth as

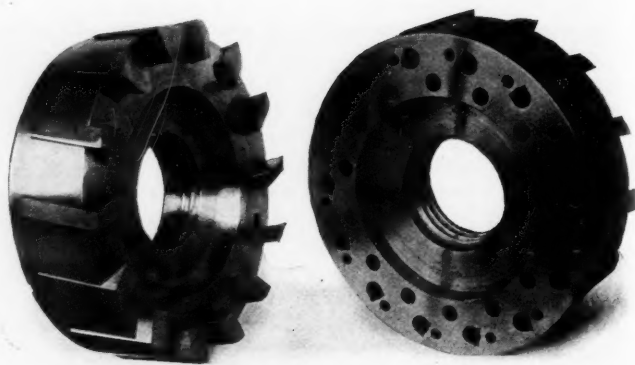


Fig. 1. Opposite Sides of the Becker Inserted-tooth Milling Cutter

they become smaller through repeated grinding. The teeth are held in the body by means of hardened tool steel pins.

The body of the cutter is made of nickel steel and the blades of "Novo Superior" steel. In assembling the cutter, it is important to observe that the blades must not drive so tight that the adjusting screws will not work them. The teeth are set back of the center line at an angle of 15 degrees and a rake of 10 degrees. In a recent test conducted with one of these cutters on a Becker high-power milling machine, the cutter was run at a peripheral speed of 115 feet per minute with a feed of  $\frac{3}{8}$  inch per revolution. Operating under these conditions, cast iron with 20 per cent steel was removed at the rate of 52 cubic inches per minute and the cutter showed no sign of chatter or vibration.

### NORTON GRINDING WHEEL STAND

This machine is the result of the experience of the Norton Co., Worcester, Mass., in the use of grinding wheels on many types of floor stands; and the designers have endeavored to incorporate into it every feature that will help to obtain greater production, and to give longer life to the grinding wheels and the machine itself. While it is not a radical departure from the machines now common in the better equipped shops, it is evident that its designers have given careful attention to such features as rigidity, safety, convenience of operation, and means of lubrication and dust removal. Particular attention has also been paid to the general appearance of the machine as indicated by its freedom from sharp corners, recesses and uncovered bolts. While

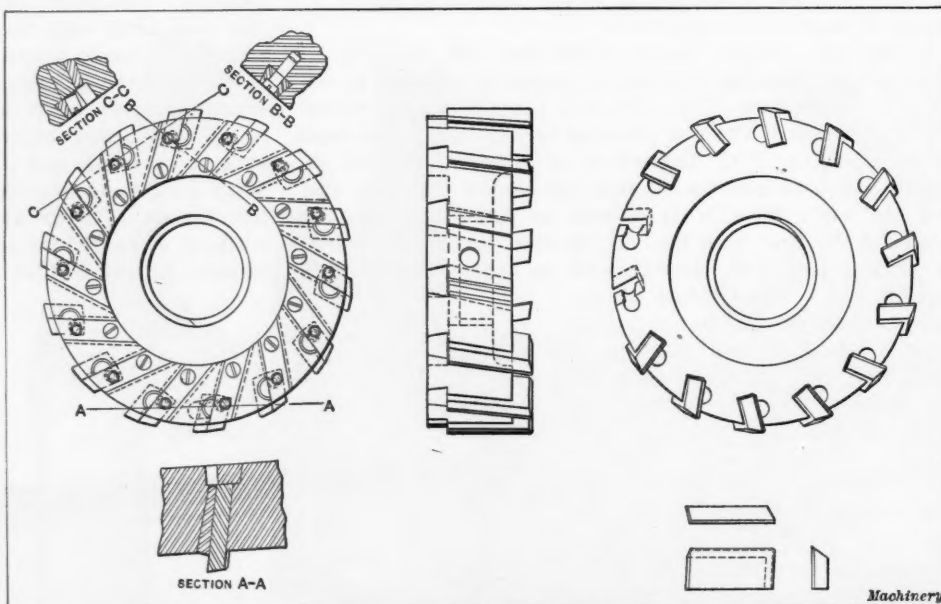


Fig. 2. Assembly and Cross-sectional Views of Becker Inserted-tooth Milling Cutter showing Construction

the foundation space occupied by the machine is small, its weight and rigidity permit of a very desirable overhang of the bearing-bed. This feature allows ample foot-room for the operator. Each bearing is divided into two parts and the large bearing surfaces help to insure long life. The diameter of the spindle in the bearings is made  $\frac{1}{16}$  inch

oversize, allowing sufficient stock for regrinding when this becomes necessary. The portion of the spindle outside the bearings is made sufficiently long to take taper wheels of  $\frac{1}{2}$  or  $\frac{3}{4}$  inch taper per foot, which have the same width of face as the maximum width of straight wheels. End play on the spindle is easily taken up. The inside flanges are fitted loose on the spindle and driven by a key, making their removal a simple matter. Taper flanges of any make may be used on these machines, if the hole is the right size, by cutting a spline in the hole of the inside flange to fit the square key in the spindle.

Oiling is accomplished by the splash system, insuring positive lubrication. The oil reservoir, which is located under and between the two parts of the bearing, holds a supply of oil sufficient for several months. The design allows ample space for the oil to drain back into the reservoir and be used over and over again. All lubricant can be easily and quickly removed from the reservoirs which are readily accessible for cleaning. Dustproof covers protect the bearings and oil chambers and an oil guard inside the bearing-chamber prevents the oil thrown up by the splasher from working out through the joints of the bearing-bed and bearing-cover. The under side of the overhanging bearing-bed is provided with a machined seat and T-slots; and the work-rest brackets, protection hoods and surface grinding attachments are secured by bolts placed in those T-slots, in which they may be attached or removed very quickly. All attachments

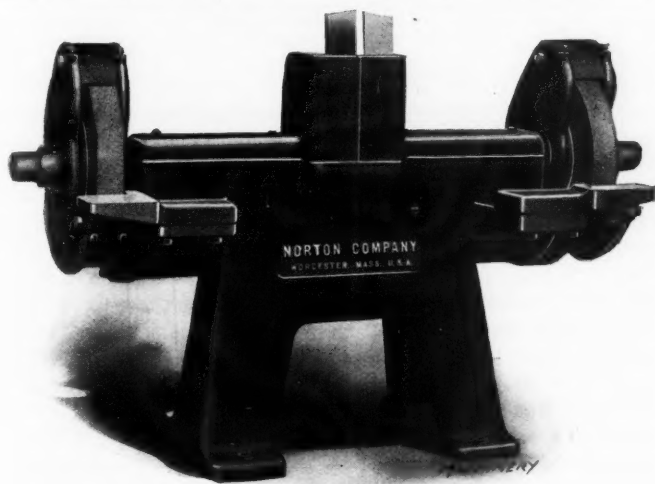


Fig. 1. The Norton Model D Grinding Wheel Stand

are independent, and interchangeable. Whenever it is desired to grind large work that requires the removal of the work-rest, the work-rest bracket can also be removed. This permits the grinding of large pieces without interference of projecting brackets, even if the wheel in use is of minimum diameter. The top surface of the work-rest is chilled, insuring long life; and is of ample size to give adequate support for large and heavy work.

A substantial belt guard, which permits any belt angle from vertical to 45 degrees, extends two inches above the top line of the maximum size of wheels. This, besides affording protection to the operator, serves to protect the belt when long pieces are ground on the surface grinding attachment. A protection- and dust-hood, designed especially for the Model D floor stand shown in Fig. 1, is for the purpose of providing protection against injury in case of accident to the wheel; and also, when the hood is connected with some suitable dust removal system, against injury to health from inhalation of dust. The bracket which supports the hood serves also as a dust exhaust pipe. The closed hood consists essentially of a heavy band of boiler plate and two heads or side plates. The hood surrounds about five-sixths of the wheel, leaving a 60-degree opening, and a heavy steel slide provides adjustment for wheel wear. The slide travels in grooves, describing an arc around a center other than the spindle center so that, irrespective of the size of a wheel, 60 degrees of the periphery of the wheel is exposed for grinding purposes and protection is always afforded. This type of hood covers the end of the spindle, thus preventing accidents

due to clothing becoming caught on the nut on the spindle. Through the employment of a special lock-nut the outer head or side plate is easily removed to permit making a change of wheels.

In addition to the Model D type of hood, the Norton Co. is also placing on the market a Model E hood which is designed along the lines of the former and adaptable to any make of floor stand conforming to the general contour of the Norton stands. In applying this hood, it is simply necessary to provide a suitable bracket to which may be attached the

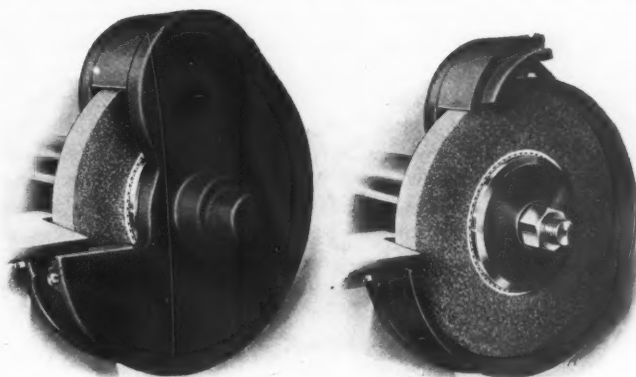


Fig. 2. Protection- and Dust-hood of the Norton Model D Grinding Wheel Stand, shown Closed and Open

inner head, which, in turn, holds the entire structure. This hood is so designed that it is adjustable about the wheel, permitting the grinding to be done on top, at the front or at the bottom of the wheel. Instead of having the bracket by means of which the hood is fastened to the wheel, serve the additional purpose of a dust exhaust pipe, the inner head of the hood is solid and the exhaust pipe is located on the boiler-plate band. The exhaust pipe is mounted on a steel plate of the same radius as the band and is firmly bolted to the latter. Model E hoods are furnished with a full size band and the exhaust connection is not attached. The user can readily cut the opening at any desired point and attach the exhaust connection after the hood is located on the machine.

These machines are made in four standard sizes with spindles  $1\frac{1}{4}$ ,  $1\frac{1}{2}$ ,  $1\frac{3}{4}$  and 2 inches in diameter, and a special machine can be built to order with a spindle  $2\frac{1}{2}$  inches in diameter. The principal dimensions of the machine with a 2-inch spindle are as follows: Distance between wheels, 62 inches; height of spindle above the floor,  $30\frac{1}{2}$  inches; length

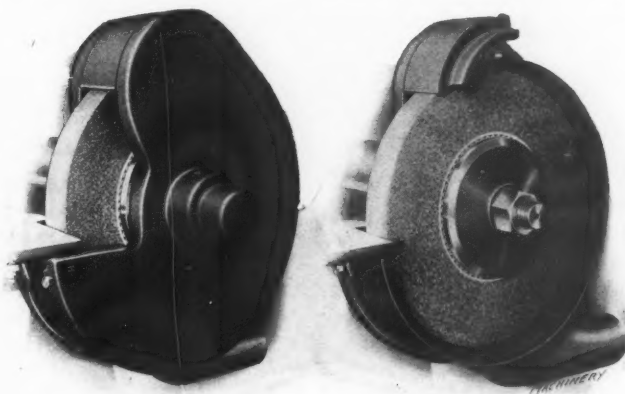


Fig. 3. Protection- and Dust-hood of the Norton Model E Grinding Wheel Stand shown Closed and Open

of bearings,  $16\frac{1}{2}$  inches; diameter of spindle bearings,  $2\frac{3}{16}$  inches; diameter of safety flanges, 12 inches; size of cone pulley steps,  $9\frac{1}{4}$ ,  $8\frac{9}{16}$  and  $5\frac{3}{4}$  inches; foundation space required 27 by 42 inches; floor space occupied by machine, 27 by  $88\frac{1}{4}$  inches; size of wheels used, 24 inches in diameter by 4 inches face width; net weight of machine and hoods, 1705 pounds.

#### FITCHBURG GRINDING MACHINES

The Fitchburg Grinder Co., Fitchburg, Mass., is the manufacturer of the 6 by 15 inch plain grinding machines shown

in the accompanying illustrations. Fig. 1 shows the front view of the style A machine and Fig. 5 shows the front view of the style B machine. Referring to these illustrations, it will be seen that a large pilot wheel has been substituted on the style B machine in place of the power table traverse employed on the style A grinder. By omitting the transverse gear box and automatic feed, it has been possible to build an efficient machine at a comparatively low price, for grinding short cylindrical pieces in large quantities. In other respects, the styles A and B machines are quite similar and the detailed description which follows is applicable to either type.

These machines are essentially manufacturing grinders for producing either straight or taper cylindrical work in quantities. The wheels used are 16 inches in diameter and 2 or 3 inches face width. The work may be supported on either dead or live centers. It has already been stated that the style A machine is fitted with power table traverse and work change gear boxes, each of which is independent of the other and provides suitable speeds and feeds for various classes of work which come within the range of this machine. A single lever provides for starting or stopping

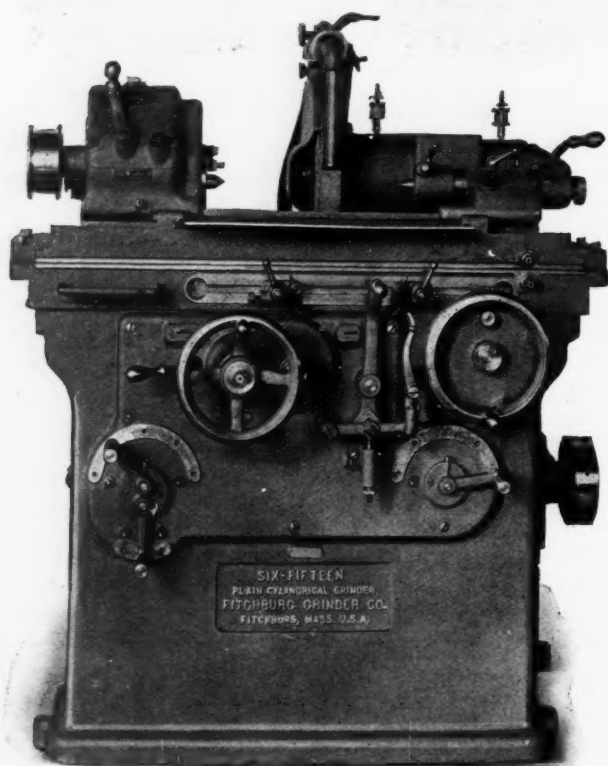


Fig. 1. Front View of Fitchburg Style A Plain Grinding Machine

the table travel at any point in its stroke and for simultaneously engaging or disengaging the traverse handwheel. The style A machine also has automatic cross feed and positive stops for use in the production of duplicate work. All shaft bearings in the machine are ground and fitted with removable bushings, and many of the bearings are self oiled.

The base of the machine is of massive proportions and internally braced to give the required rigidity. It is of compact design and the units are so located as to be easily accessible. Any unit may be removed from the machine without requiring the other units to be disturbed. Wide bearing surfaces of the V- and flat type are provided. An oil reservoir for automatically oiling the ways is located in the bed. A pan of liberal proportions is provided at the back of the machine to catch the water. The wheel spindle is made from a special alloy steel, and after hardening, is ground and lapped to the required size. Bearings are bushed with phosphor-bronze, and large self-feeding lubricators are provided to insure having a liberal supply of oil delivered to the boxes.

The wheel head is of massive proportions, and slides on long flat- and V-ways. It is held in place by gravity and is provided with a safety gib to guard against danger of lifting

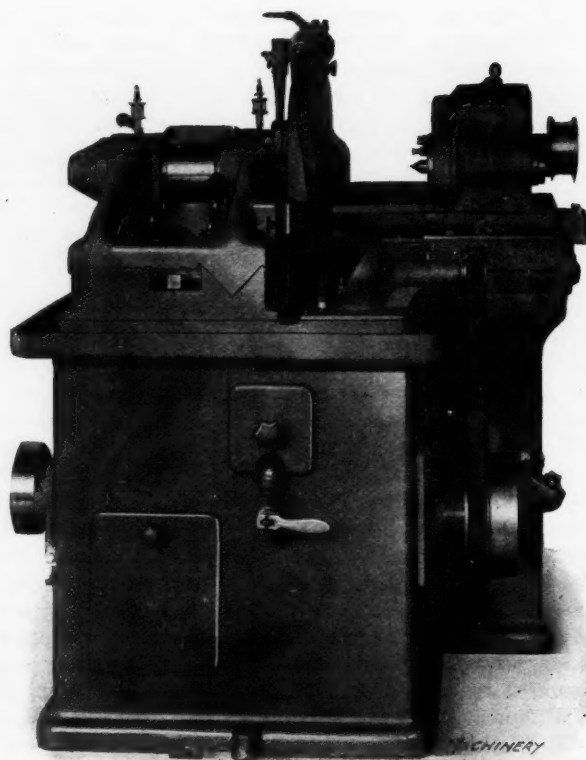


Fig. 2. Opposite Side of Machine shown in Fig. 1

under normal conditions. The table slide is unusually heavy and is powerfully ribbed to resist torsional strains. The swivel table has a liberal bearing on the table slide and pivots on a large central stud. This table provides for grinding tapers; it is graduated to read in degrees and tapers expressed in inches per foot.

The headstock slides on the ways of the table and is clamped in position by a hook bolt. It is of the geared type, the spindle being ground and fitted in removable bronze bushings which may be replaced when worn. The moving parts are lubricated by the splash system. The spindle is hardened and finished by grinding and lapping; it may be revolved for grinding parts which require a live spindle. The work is started and stopped by a lever mounted on the headstock. The footstock is secured to and preserves its alignment on the swivel table in the same manner as the head-

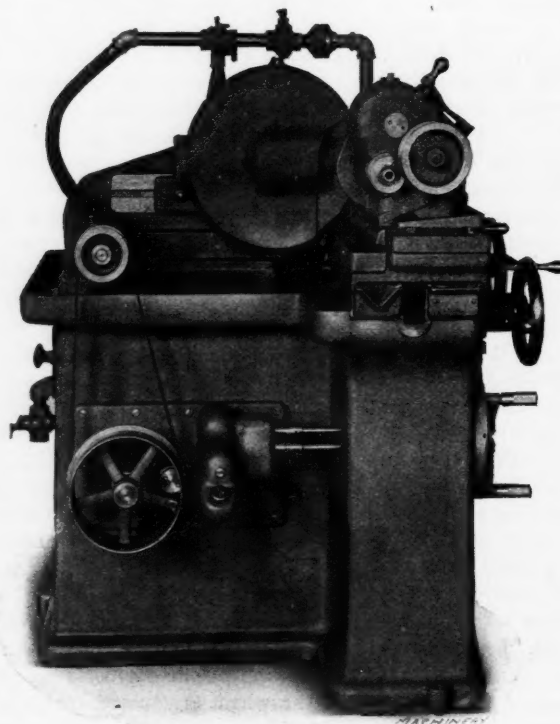


Fig. 3. End View of Fitchburg Style A Plain Grinding Machine

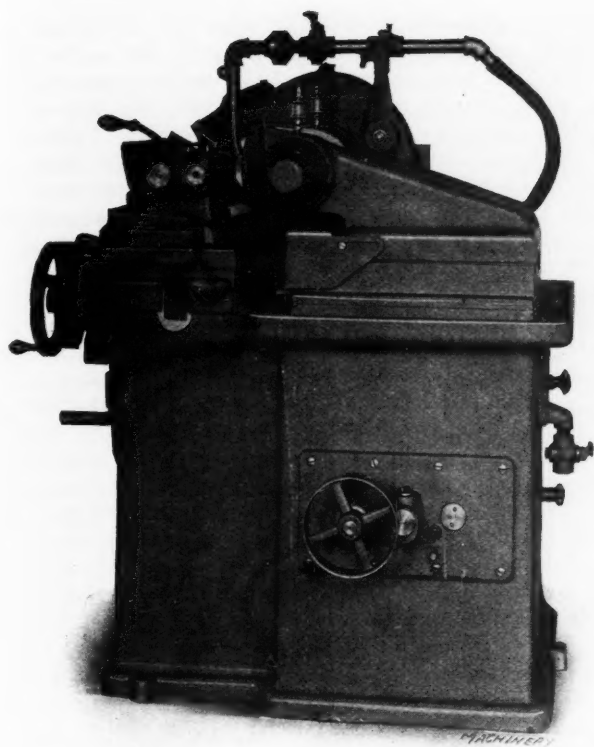


Fig. 4. Opposite End of Machine shown in Fig. 3

stock. The wheel side of the footstock base and the spindle are flattened, which reduces the movement of the wheel slide when truing the wheel. The diamond point for this purpose is mounted on the footstock spindle which may be rigidly clamped for supporting the center to the work.

The universal back-rests provided on this machine have both vertical and horizontal movement and very delicate adjustments can be made. The pump is of the fan type and revolves in a horizontal plane; it is kept immersed so that it is constantly primed and no packing is required. The water tank is of ample size and provided with settling pans which are easily accessible for cleaning. The self-contained countershaft provides three changes of speed for the grinding wheel and all rotating members run on Hyatt roller bearings. All overhead belt changes are operated from the

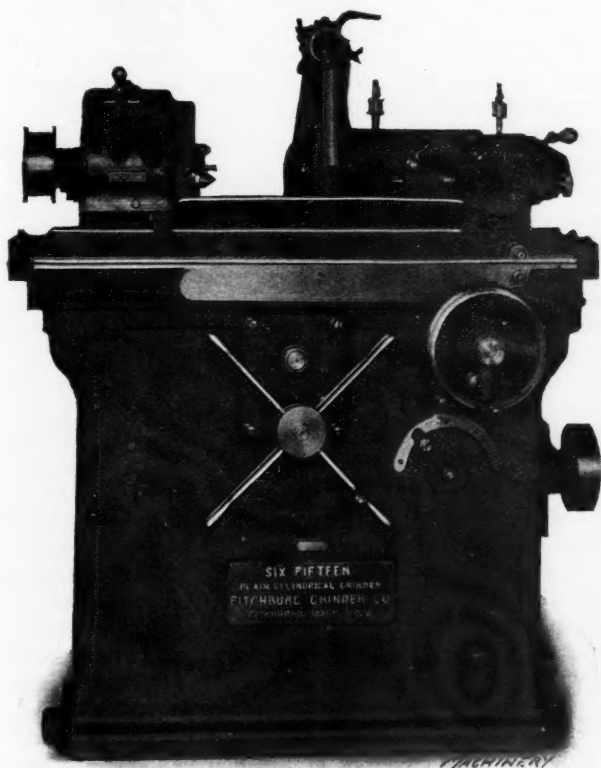


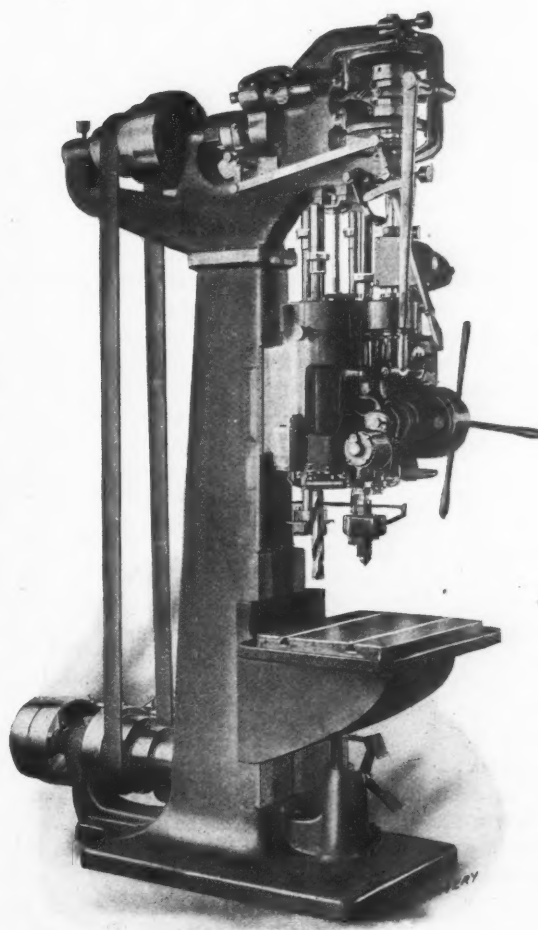
Fig. 5. Front View of Fitchburg Style B Plain Grinding Machine

front of the machine. The equipment of the grinder includes self-contained overhead works, a universal back-rest, a center grinding attachment, water guards, dogs, two grinding wheels and the necessary wrenches.

The principal dimensions of the style A machine are as follows: Swing over table, 6 inches; distance between centers, 15 inches; swivel table graduated to an angle of 13 degrees or to a taper of 5 inches per foot; number of work speeds, 10; range of work speeds, 30 to 345 R. P. M.; number of traverse table feeds, 10; range of traverse table feeds, 10 inches to 92 inches; number of grinding wheel speeds, 3. The power developed by the motor which drives the machine is 7 horsepower. The floor space occupied is 52 by 66 inches; and the net weight of the machine, 3600 pounds. Similar dimensions apply to the style B machine except that there are no power movements for the table, and the net weight of the machine is 3350 pounds.

### TURNER AUTOMATIC TURRET DRILL

With the view of increasing production by having a series of tools available for performing successive operations on a piece of work without requiring it to be re-set or the



Turner Model F Heavy-duty Turret Drilling Machine

tools to be changed, the Turner Machine Co., Danbury, Conn., has brought out the Model F turret drill which is illustrated herewith. This machine is of heavier construction than the other types of turret drills built by this company, the present machine being intended for relatively heavy work. It frequently happens, however, that some small holes have to be machined in a piece in which it also is required to drill relatively large holes, and to enable these small holes to be drilled efficiently, the use of drill speeders is recommended. Each spindle in the turret carries a different tool which is successively and automatically registered in exactly the same position. The mechanism by which this automatic indexing is obtained is not complicated and the machine can be operated rapidly by an average workman and produce work of extreme accuracy. The accompanying illustration will give the reader an idea of the design.

The column and base are cast integral, the column being of rectangular section and tapering from 8 by 15 inches at the base to 5 by 11 inches at the top; it is internally ribbed and cross braced to provide the required rigidity. It will be seen that the turret is vertical; it rotates automatically and when the operator returns the spindle to its full height, the turret indexes to bring the next spindle into the operating position. The detents are adjustable for both wear and accuracy. They are made of a special chrome-vanadium steel which has a compressive strength exceeding 400,000 pounds per square inch when heat-treated according to the method used by this company. As the detents are located further from the center of the turret than the working tools or spindles, a high degree of accuracy is obtained. The spindles are of heat-treated nickel steel, the elastic limit of which is in excess of 90,000 pounds per square inch; the spindles are completely finished by grinding. The spindle driving gears are made of heat-treated chrome-nickel steel, and Feichtel & Sachs ball thrust bearings are mounted under the spindle gears on the top of the turret and also at the bottom of the spindle in order to support the thrust of the tools and increase the smoothness of drive.

The feed mechanism is driven from the vertical shaft which drives the spindle and the feed may be engaged or disengaged without stopping the machine. An automatic trip is provided to throw out the feed at any predetermined point in the spindle travel. The feed gears are enclosed in a dust-proof case and provide four changes of feed, the drive being direct on the coarser feeds. The feed gears, in connection with the two spindle speeds, provide a range of eight changes for the machine. The feed is actuated by helical gears which operate very smoothly. The feed gears are only running when the feed is in operation. Three sets of helical gears are used in the feed mechanism; the first two sets run at higher speeds and lower pressure than the final set. The thrust of the first two sets of gears is taken by a system of multiple washers and the thrust of the final set is carried by a ball thrust bearing. One gear of each pair is of chrome-nickel steel and the other is of a special grade of hard bronze.

The spindles may be fed by either hand or power. For the hand feed, either a handwheel or lever is used, the former being more sensitive and better adapted for profiling and other milling operations. The inactive spindles are positively locked in their extreme upper position and as each spindle is automatically swung into the working position, the positive lock is released. The spindle projects approximately  $1\frac{1}{2}$  inch under the sleeve and a ball thrust bearing is interposed between the nose of the spindle and the end of the sleeve. The bearing is packed with grease and surrounded by a dust-proof brass collar. The sleeve is  $12\frac{11}{16}$  inches in length and the spindle has a 4-inch bearing within the sleeve at each end, with an oil chamber at the center. The upper end of the spindle is guided in the turret. This method of supporting the spindles close to the nose—together with the long bearings placed far apart—gives exceptionally rigid support.

A feature which makes the machine suitable for driving small and delicate tools, such as drills and taps, is that each tool has its own individual feed, which may be operated by hand if desired. This offsets the weight of the machine, which would otherwise be poorly adapted for driving delicate tools. It is not feasible to provide in a single machine the extreme range of speeds and feeds which are necessary for driving tools of widely divergent sizes. For example, a machine powerful enough to drive drills from 1 to 2 inches in diameter could scarcely be made suitable for driving small sized drills. Yet it is often desirable to have such operations follow each other on the same piece of work. As previously mentioned, the Turner turret drill is adapted for work of this character by using drill speeders to drive the smaller sized tools.

The back gears are operated by a friction clutch and may be rocked out of engagement when not in use, in the same way that the back gears of a lathe are disengaged. The gears which operate the reverse mechanism for tapping and threading operations, back out the tap or die at 1.6 times the forward speed. The tapping gears may be disengaged by means of an intermediate gear and friction clutch when the tapping mechanism is not required. Both the back gears and the tapping gears may be engaged or disengaged without requiring the machine to be stopped. The control levers for all members of the machine are within easy reach of the operator. All shaft bearings are bronze bushed so that they may be easily renewed when necessary. Wherever it is possible, lubrication is provided by grease cups. The table is adequately ribbed and has a working surface 18 by 23 inches in size. The oil groove is of ample proportions to prevent lubricant from overflowing, the lubricant being supplied by a gear-driven pump and delivered through a flexible supply pipe. The table is supported from the knee, on which it has a three-point bearing. In changing the machine over from one job to another, it is merely necessary to change the tools for the successive operations to be performed, and to locate the jig or fixture that is to be used on the table. Each tool

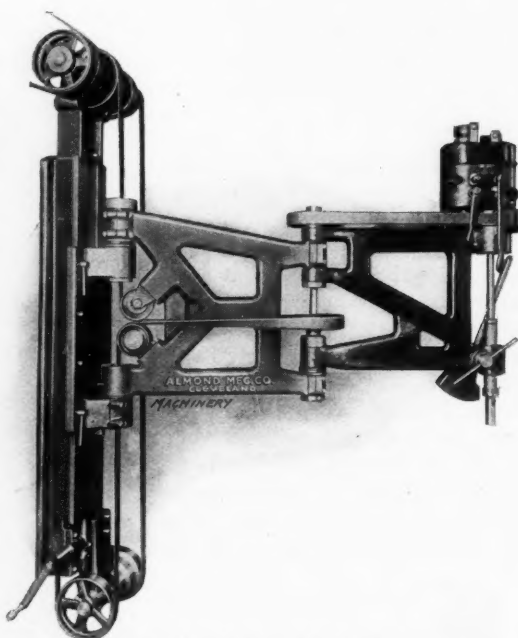


Fig. 1. Almond Post Type Radial Drill with Arm extended

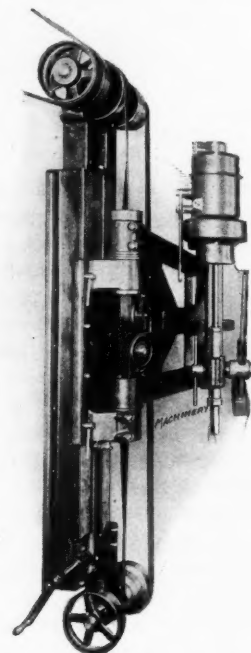


Fig. 2. Machine shown in Fig. 1 with Arm Closed

is automatically brought to the same center until the sequence of operations has been completed.

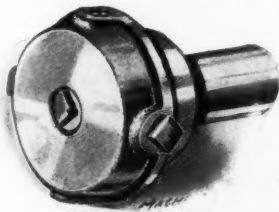
### ALMOND POST TYPE RADIAL DRILL

A post type radial drill designed to be fastened to either a column or wall, and used for light drilling and tapping operations, is illustrated in Figs. 1 and 2. This machine has a drilling radius of 4 feet and will handle twist drills up to  $\frac{7}{8}$  inch and standard taps up to  $\frac{3}{4}$  inch in diameter. The machine is entirely self-contained and may be driven direct from the lineshaft or by an individual constant-speed motor. Six changes of spindle speed are provided, these speeds being in geometrical progression and ranging from 175 to 1000 revolutions per minute. The machine is equipped with ball bearings throughout so that it is well suited for operation at high speed. The saddle that carries the swinging arm has a vertical adjustment of 2 feet, an elevating screw with the thrust supported by a ball bearing being provided for this purpose. The main driving belt passes through the trunnions on which the main frame swings, so that the belt tension and alignment are not affected by the swinging of the arms or by the vertical adjustment. Provision is made on the machine for maintaining the tension of the driving belts at the required point. The weight of the swinging frame is supported by ball thrust collars and provision is made for taking up any wear which may develop at the trunnions.

The geared tapping attachment is one of the features of this machine. When the spindle is run on either of the three open belt speeds which are obtained by the three steps on the cone pulley, the reversing gears are not running, these gears being automatically locked out of engagement when the machine is operating under these conditions. When the tapping attachment is thrown into operation, the spindle speed is reduced to 1/3 of the open belt speed and a quick reverse of approximately 2 to 1 is available. Owing to the fact that the belt speed is not reduced, this arrangement gives ample power as well as the proper speeds for large drilling, reaming, counterboring and stud set operations, in addition to tapping. The change from the drilling speed to the tapping speed is made while the machine is running by means of the operating levers shown on the side of the head. The hand feed lever has a ratchet adjustment and a counterweight is attached to it. This counterweight supports the weight of the spindle and tool, and provides for returning the lever into a convenient position for the operator. This machine is manufactured by the Almond Mfg. Co., Cleveland, Ohio.

### SMILLIE TURRET LATHE DRILL CHUCK

C. M. Smillie, 130 E. Larned St., Detroit, Mich., is the manufacturer of the turret lathe drill chuck illustrated herewith. This chuck is not self-centering. It is provided with means for setting the tool either way from the chuck center in order to line the tool up properly with the machine spindle. This adjustment is made by two cap-screws which move the jaws in a transverse slot in the body of the chuck. The chuck is set in the turret with the jaw slot either horizontal, vertical or at an angle, with the line of travel of the jaws crossing the axis of the machine spindle. The adjusting



Smillie Turret Lathe Drill Chuck

screws are then regulated to bring the tool into exactly the required alignment. If it is necessary to remove the tool for grinding, this is done by simply loosening one screw and after grinding the tool, replacing it in the chuck and tightening the screw up again. Where this method is followed, the alignment is not disturbed. The chuck can be quickly set up on the machine and it is of simple and substantial design so that ample wear is assured. The tool is made in three sizes which have respective capacities for drills from No. 42 to 1/2 inch, from 1/4 inch to 3/4 inch and from 1/2 to 1 inch in diameter.

### F. E. WELLS TAP WRENCH

An adjustable tap wrench of simple design, which is a recent product of F. E. Wells & Son Co., Greenfield, Mass., is illustrated herewith. This wrench consists of four essential parts in addition to two connecting pins, and there is practically nothing to get out of order. The centers are drop-forged and the handles and jaws are in one piece. An

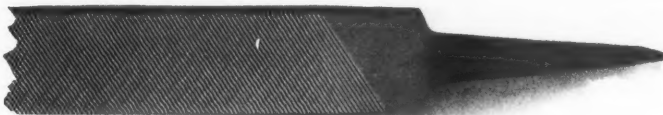


F. E. Wells Tap Wrench of Simple Construction

independent screw is provided for tightening the movable jaw on the tap shank, the arrangement being such that the jaw cannot work loose. The jaws are milled flat to give the best possible grip on the shank; they are made of carbon steel, hardened and tempered. It will be seen that the center has a mottled or "gun metal" finish and that the handles are knurled to prevent the hands from slipping when they are covered with oil. This tap wrench is made in eight sizes and the range of the complete set is from 1/16 to 1 1/2 inch.

### AMERICAN SWISS FILE & TOOL CO.'S "WAVECUT" FILE

The American Swiss File & Tool Co., 24 John St., New York City, has added to its line a file known as the "wavecut." The cut consists of diagonal rows of cutting edges which give the file its wavy appearance—hence the name "wavecut." This new file removes metal in curly shavings rather than the granular filings produced by ordinary files. The new file operates at a high efficiency, and it is durable and of excellent appearance. Tests which have been



American Swiss File & Tool Co.'s New "Wavecut" File

made show that the "wavecut" file is equally serviceable in filing silver, brass, copper, nickel, cast iron and steel. At present, these files are only being made in the hand shape, and in 8-, 10-, 12- and 14-inch sizes, each size being made in coarse, medium and fine cuts.

Heretofore, the American Swiss File & Tool Co. has not made files exceeding 12 inches in length, but in response to an insistent demand, 14-inch files have been added and files of this size are now carried in stock. These files are made in the hand, round, square and mill shapes and three different cuts.

### WATERBURY-FARREL SWAGING MACHINE

The demand for machines for pointing, reducing and shaping round stock and tubing by the cold process has led the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., to build a line of standard rotary swaging machines which are made in several different sizes with capacities from 1/4 to 1 1/2 inch in diameter. These machines are largely used in rod and tube mills for pointing material preparatory to drawing it through dies on a "bull block," and they are extensively used in the manufacture of various staple articles in the metal trade such as hose nozzle, tapered shells and screw and bolt work.



Waterbury-Farrel Swaging Machine for reducing Round Bar Stock or Tubing

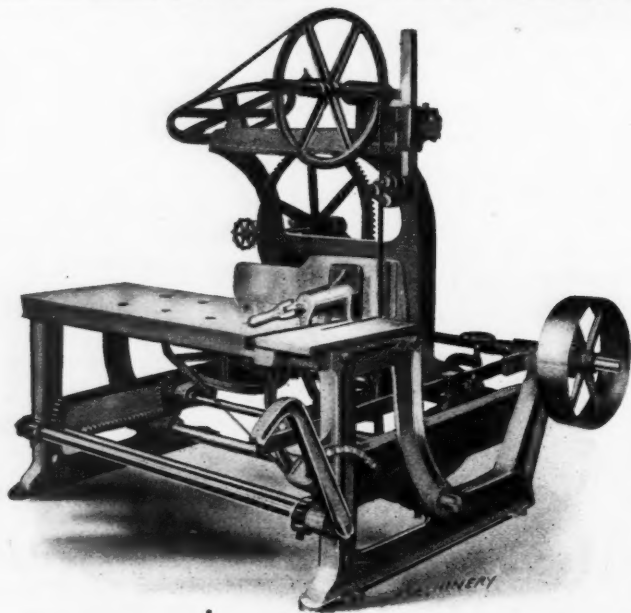
These swaging machines are extensively used by jewelry manufacturers for reducing a bar or ingot of pure or plated metal to a small size, which is suitable for drawing on individual blocks or continuous wire-drawing machines. They are of very simple construction and built exceptionally strong to enable them to stand up under various severe service conditions.

The design has been worked out in such a way that the dies and working parts of the mechanism are readily accessible. In the operation of this machine, a series of very rapid impressions is made in the rod or tube by a pair of die blocks which have a concentric or rotary motion around the work, thus effectually eliminating the possibility of developing a fin or burr.

## SHINN METAL CUTTING BAND SAW

M. E. Shinn & Co., 1846 W. Lake St., Chicago, Ill., are now building the vertical, gravity-feed band saw which forms the subject of this article. This machine is designed for cutting metal into various lengths and at any required angle. It will be evident from the illustration that the design of the machine is such that there is nothing to interfere with the bar to be cut, no matter what its length may be. An easily adjusted swiveling table back, and a vise which operates in a groove on the table, enables the material to be cut at any angle, and to be rigidly held during the cutting operation. By loosening a single cap-screw, the saw may be adjusted to provide for ripping sheet metal lengthwise.

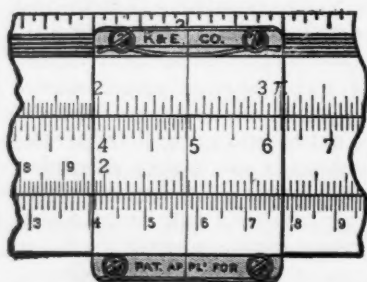
An important feature of this machine is the way in which the non-cutting part of the saw is returned, by passing over



Shinn Metal Cutting Band Saw equipped with Gravity Feed

idler wheels in such a way as to obviate the possibility of its interfering with the material that is being cut, and at the same time leaving the cutting edge of the saw perfectly vertical and free from twist. This arrangement enables the saw to run straight in the line of cut and insures accuracy and long life to the saw blade. The frame supporting the band saw wheels is mounted upon four ball bearing wheels, and provision is made for holding the frame in accurate alignment. The inclination of the track-way on which the wheels supporting the saw frame run is altered by means of the operating lever shown at the front of the machine at the right-hand end, the feed being regulated by setting the track-ways at an angle in this way. The cutting part of the saw maintains a vertical position during the entire length of cut and the gravity feed is constant although it can be increased or decreased by the lever referred to.

The action of the machine is entirely automatic and after the cut is completed, the saw is stopped by means of a dog operating a clutch attached to the driving pulley. This machine has a capacity for cutting metal up to 12 by 11 inches in size and leaves a smooth finished surface. The floor space occupied is 45 by 45 inches. The band saw used is 15 feet 6 inches long by  $\frac{5}{8}$  inch wide by 0.0312 inch thick. An idea of the capacity may be gained from the fact that the machine will cut a  $2\frac{1}{2}$ -inch cold-rolled shaft in 3 minutes.



Frameless Indicator for K. & E. Slide Rules

## K. &amp; E. SLIDE RULE INDICATOR

It frequently happens that after setting the indicator or "runner" on the Mannheim or duplex type of slide rules made by the Keuffel & Esser Co., Hoboken, N. J., it is impossible to read the result because certain important figures are hidden by the frame which holds the glass. Several figures are often obscured in this way, causing some inconvenience to the user of the rule. With the view of overcoming this difficulty, the frameless indicator shown in the accompanying illustration has been designed and patented by this company. It will be evident from the illustration that there is nothing to cover the scales on the rule, so that every figure is always visible. This improvement greatly increases the ease and rapidity with which a slide rule can be used and will doubtless be appreciated by the many engineers, draftsmen and others who have occasion to use these useful instruments in making rapid calculations. Hereafter, the K. & E. adjustable slide rules of the Mannheim and duplex types will be equipped with frameless indicators.

## AMES BENCH FILING MACHINE

The Ames bench filing machine designed particularly for work on which it is desired to file surfaces perfectly straight and true to any required angle is shown in Fig. 1. This machine is adapted for filing dies, jigs, templets and for similar classes of service. The height from the bench to the table of the machine is 18 inches and the table is 9 inches in diameter. The length of stroke may be adjusted from 2 to 5 inches to meet the requirements of various classes of work. It will be seen that the machine is driven by a three-step cone pulley, and an idea of its size will be gained from the fact that the machine and countershaft weigh about 145 pounds.

This filing machine will not take regular stock files. Special parallel files are used which are supported at both ends, as in the case of a jig saw. These special files are 8 inches in length and are used in much the same way as a hack-saw blade; either saws or files can be used in the



Fig. 1. B. C. Ames Bench Filing Machine

machine and accurate work is produced in both cases. The machine is particularly adapted for die work; and the dies are taken from the machine with straight, true surfaces of known clearance. This machine is a recent product of the B. C. Ames Co., Waltham, Mass.

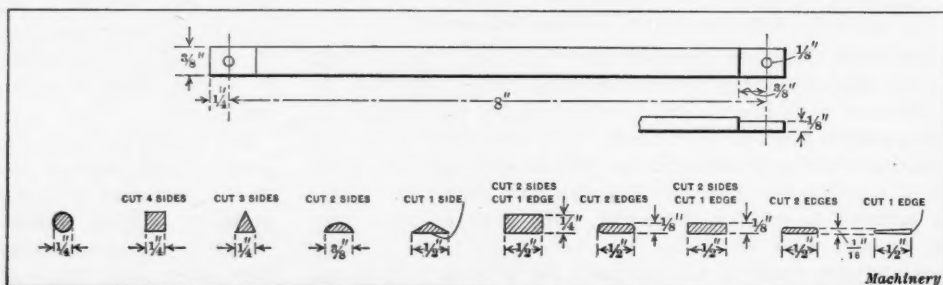
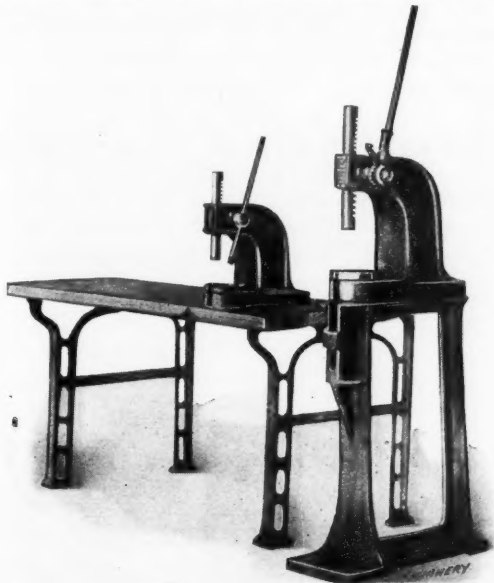


Fig. 2. Examples of Special Files for Machine shown in Fig. 1

### EAMES ARBOR PRESSES

The G. T. Eames Co., Kalamazoo, Mich., has added to its line of arbor presses three small sizes known as the Nos. 0, 1 and 1½. These small machines were developed to meet the demand of shops where the work requires no great amount of power. The Nos. 0 and 1 machines are built with the ordinary vise type of handle, while the No. 1½ machine has a ratchet attachment so that the lever may be used in

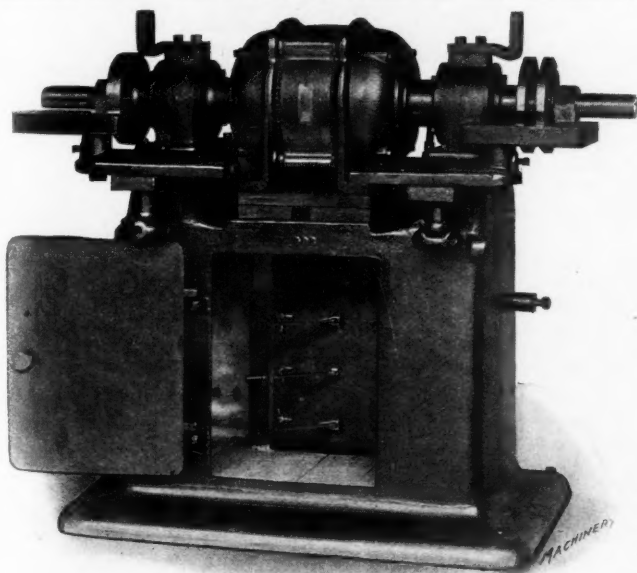


Eames Nos. 0 and 1½ Arbor Presses

the most convenient position. The design and construction of these tools is in accordance with the most modern practice and is such as to enable them to stand up under hard service conditions.

### RANSOM BALL BEARING GRINDER

The accompanying illustration shows a motor-driven dry grinding machine built by the Ransom Mfg. Co., Oshkosh, Wis. The motor is 5 horsepower and runs at 900 revolutions per minute; it is intended for use on a 60-cycle, 3-phase circuit. The motor is bolted to the main frame of the machine and is usually of the open type, although it can be enclosed if so desired. The rotor spindle is 2 inches in diameter at the ends where the wheels are mounted and 2½



Ransom Ball Bearing Motor-driven Grinder

inches in diameter between the bearings. It is made of high-carbon steel and supported on either side of the motor by S. K. F. ball bearings of the double row, self-aligning type. The ball races are exceptionally heavy. The grinder is equipped with two abrasive wheels 24 inches in diameter by 4 inches face width.

With the view of testing the durability of the bearings, one of these machines was recently kept in constant operation on heavy foundry grinding for a period of five months. Two operators were employed to have the machine running under full load at all times. At the end of this test a careful examination failed to show any appreciable wear in the bearings. The wheels are covered by steel guards provided with exhaust pipe connections. The guards have been removed from the machine shown in the illustration in order to illustrate the bearings to better advantage, but the supporting points for the guards are shown. Although the ball bearings cost more than babbitted bearings, they are the means of reducing friction and maintenance costs, preventing the rotor from hitting the starter due to play which may develop in plain bearings, and the ball bearings are easily replaced should they become worn. As previously mentioned, the machine shown in the illustration is equipped with wheels 24 inches in diameter by 4 inches face width, but grinders of this type are built in sizes for wheels from 16 inches in diameter up. They are made in both the belt- and motor-driven types.

### ROCHESTER CASEHARDENING FURNACE

The Rochester Casehardening Co., Rochester, N. Y., has recently brought out the oil-fired furnace shown in Fig. 1, which was designed by G. L. Schuetz, the manager of this company. While the furnace can be supplied in several different sizes, the one in the illustration has a firebox 12 inches high by 24 inches wide by 48 inches long. For convenience

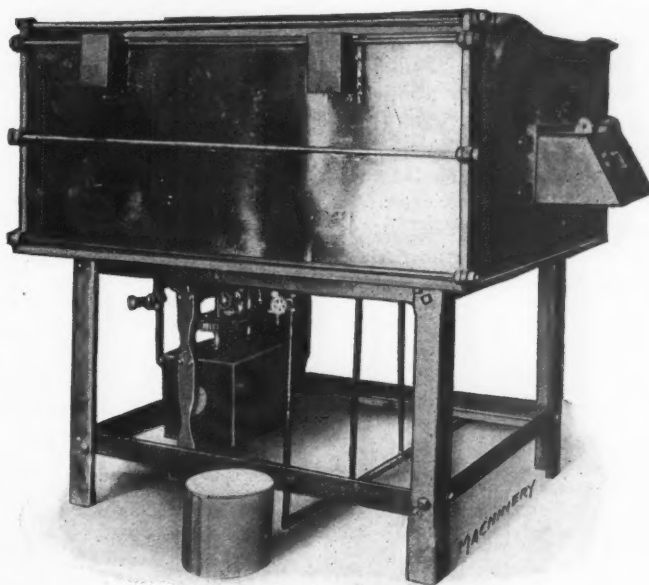


Fig. 1. Rochester Casehardening Furnace

in loading the furnace a door is placed at the rear end in addition to the one that is shown at the front.

This furnace is of the over-fired oil burning type, although it can also be equipped to burn gas. The oil burners are two in number and are located at opposite sides of the furnace near the top. The roof of the furnace is arched and the final combustion takes place in the upper part of the chamber, close to the roof. There is no vent in the roof of the furnace, it being claimed that the combustion is so complete that no objectionable products are given off. It is also said that because there is no vent, the opening of the furnace door does not create a draft.

This furnace is fitted with revolving sections in the floor of the firebox so that work requiring very particular treat-

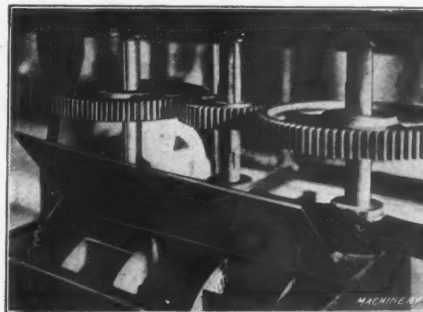


Fig. 2. Mechanism for revolving the Sections of the Furnace Floor

ment may be heated evenly. One of the floor sections is shown lying in front of the furnace. This is 9 inches thick and represents also the thickness of the walls at all sections—a feature that makes a great saving of fuel. The revolving sections of the furnace are rotated by the same air pressure that is supplied for atomizing the oil in the burners. The rotating mechanism is shown in detail in Fig. 2 and consists of a fan box having two bladed fans, against whose blades the air is directed. From the fan shaft, bevel gearing transmits motion to a central shaft, and from a spur gear on this shaft the shaft of the two revolving sections are turned by means of other spur gears. The amount of power required for turning the sections is extremely small, even when the furnace is filled with work. The fan travels at a rate of four hundred revolutions per minute and the revolving plate turns at a speed of 1.7 revolution per minute.

One of the principal advantages claimed for this furnace is that it can be operated on an extremely small amount of fuel. On average work the furnace shown in the illustration uses but two and one-half or three gallons of crude oil per hour. Therefore, at the present price of oil, the furnace can be run at a cost of from twelve to fifteen cents per hour.

### KOKOMO HIGH-SPEED DRILL

Recognizing the need of more perfect lubrication of the high-speed parts of vertical drilling machines, the Superior Machine Tool Co., Kokomo, Ind., has added to its line a 21-inch machine in which the friction back-gears and spindle driving gears are completely encased in oil retaining housings. This is the means of avoiding damage due to failure on the part of the operator to pay the necessary attention to oiling his machine. In addition to serving as a means of lubrication, these housings completely enclose the gearing and protect the operator or those passing the machine from injury.

The back-gear case is cast integral with the yoke, with the exception of the gear case cover. It is completely machined as a unit ready to receive the removable bronze bushed bearings with which the machine is equipped throughout. The gear case cover is packed to form an oil-

tight compartment in which the splash system of lubrication may be employed. One supply of lubricant will last for months and assure having the parts lubricated in a way which prevents undue wear. In addition, the gears and bearings are protected from dust and dirt and it is impossible for oil to be thrown on the floor or operator. In designing the machine, particular attention has been paid to the provision of means for rapid and constant production, together with a high degree of accuracy. All bearings are bronze bushed and the gears are cut from steel. The machine is equipped with friction back gears and a patented friction quick return.

### INTERNATIONAL LATHE REVERSE MECHANISM

The International Machine Tool Co., Indianapolis, Ind., has recently designed a mechanical reverse mechanism for use in connection with the "Libby" heavy-duty turret lathe. This

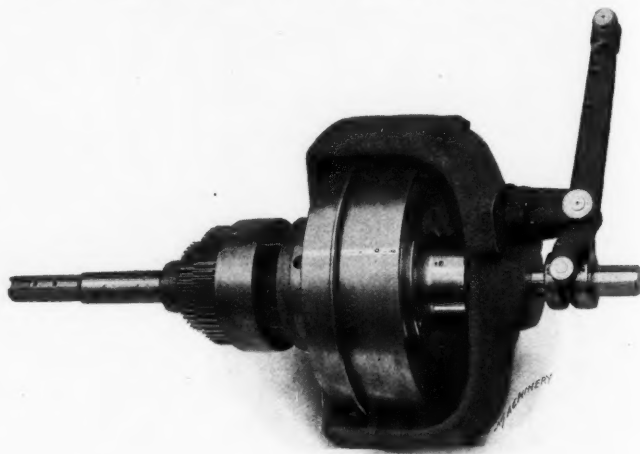


Fig. 1. Reverse Mechanism for Use on the "Libby" Turret Lathe does away with the necessity for using a reversible countershaft or reversing motor in cases where the performance of tapping operations requires the lathe to be reversed at fre-



Fig. 1. Kokomo 21-inch Self-oiling Drill

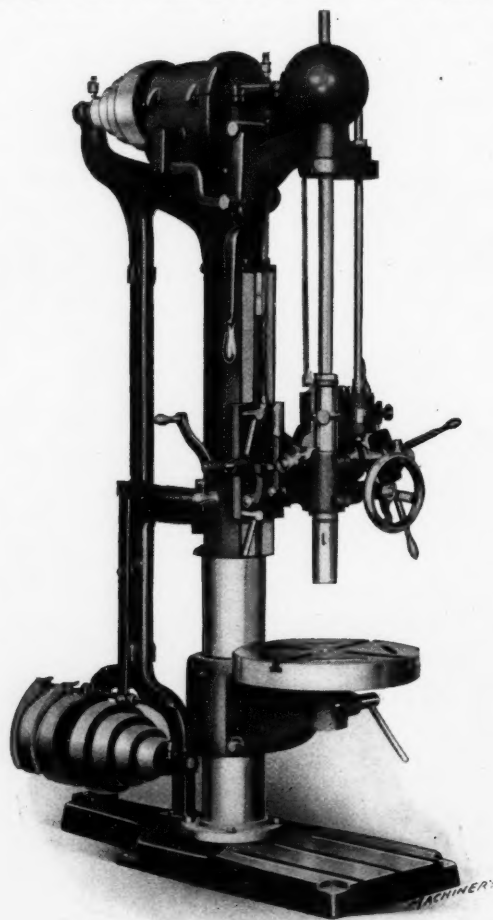


Fig. 2. Opposite Side of Machine shown in Fig. 1

quent intervals. Fig. 1 shows the complete reverse mechanism and reference to this illustration will make it clear that this is a self-contained unit which can be easily applied in place of the standard driving pulley, thus making it feasible to add this equipment to any 18-inch "Libby" turret lathe which is now in service. Fig. 2 shows the reverse mechanism set up on a machine and the control at the front of the machine

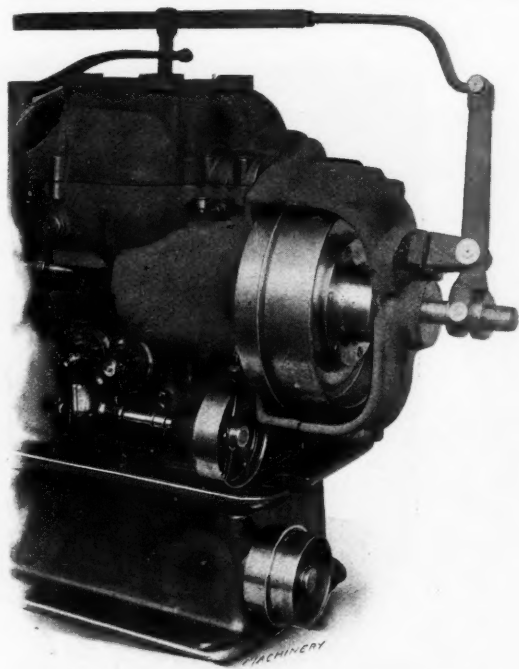


Fig. 2. Reverse Mechanism in Place on the Lathe

where all of the control levers are located. This reverse mechanism is of strong and compact design and is sufficiently durable to stand up under the most severe operating conditions which exist in the average machine shop. All gears are of steel and all bearings are bronze bushed. The gears are engaged by a band friction  $7\frac{1}{2}$  inches in diameter which is controlled from the front of the machine as previously mentioned.

## NEW MACHINERY AND TOOLS NOTES

**Truck Crane:** General Vehicle Co., Long Island City, N. Y. An electrically-driven truck crane which can be run about the shop to enable heavy castings and other parts to be handled. The crane has a capacity for lifting work up to 2000 pounds in weight.

**Autogenous Welding Outfit:** Waterhouse Welding Co., Boston, Mass. A welding and cutting torch which may be used in connection with any type of pressure generator, although it is particularly adapted for use in connection with the safety storage type of acetylene cylinder and an oxygen tank.

**Two Electric Tachometers:** Electric Tachometer Co., Philadelphia, Pa. One of these instruments is a recording tachometer and the other is a combination recording tachometer and cut-meter, which enables surface speeds to be determined in feet per minute. The instrument can be placed at any desired distance from the shaft, the speed of which is to be determined.

**Multiple Spindle Drilling Machine:** Michigan Press Co., Ypsilanti, Mich. A machine especially designed for drilling gas burners, but which could also be applied to good advantage on a variety of similar classes of work. The capacity is for drilling from 50 to 100 holes simultaneously in pieces up to 10 inches in diameter. The drills are driven by a crank motion at one end of the spindles.

**Cutter Grinder:** Flint Specialty Co., 16 Waltham St., Boston, Mass. A grinder adapted for sharpening various types of cutters such as gear cutters and a variety of other formed cutters. No attachments are required except in handling such work as sharpening and backing off saw teeth. The capacity of the machine is for gear cutters up to 3 pitch and saws up to 8 inches in diameter.

**Gear-cutting Attachment:** Garrett Attachment Co., 14th Ave. and Clinton St., Nashville, Tenn. An attachment which enables milling, gear-cutting and drilling operations to be performed on the lathe. In addition to facilitating work of this nature, the attachment may be used on an up-

right drill for drilling holes in plates or shafts, where it is necessary to have the holes equally spaced.

**Horizontal Milling Machine:** Becker Milling Machine Co., Hyde Park, Mass. A high power machine equipped with single pulley drive. The spindle is belt-driven, and the machine is double back geared. These millers are built in four sizes of plain and four sizes of universal machines, and the design is similar in many respects to the high power vertical miller of this company's manufacture.

**Regenerator Furnace:** W. S. Rockwell Co., 50 Church St., New York City. A furnace for use in the forge shop, in which a special economizer shield is provided over the working opening to prevent the loss of the large amount of heat which usually escapes at this point. A novel arrangement of blast acts as a barrier between the operator and the furnace, thus enabling him to work closer to the furnace than would otherwise be possible.

**Tumbling Barrel:** Warner Bros. Co., Bridgeport, Conn. A tilting tumbling barrel which is intended for cleaning and polishing small stampings, forgings or castings. The barrel may be used for wet or dry rolling of plated stampings, a method which is now finding application in place of hand burnishing. The machine is driven by a single pulley and friction clutch operated by a lever conveniently located for the operator.

**Broaching Machine:** Pawtucket Mfg. Co., Pawtucket, R. I. A machine designed to cover a wide range of broaching operations. It is operated by a rack and pinion, the pinion and pinion shaft being cut from a single steel forging; and the rack which operates the cutter bar is a steel casting. The work is held in position by means of a bushing through which the broach passes; consequently, it is unnecessary to fasten the work to the machine.

**Pneumatic Hammer:** Pennsylvania Pneumatic Co., Erie, Pa. A pneumatic hammer for use in the manufacture of die stamped parts from sheet metal. This hammer handles the classes of work which are ordinarily produced by a board drop hammer. The special object in designing this tool was to eliminate the board, friction rollers, gears, clutches, automatic trips and other parts of a somewhat complicated mechanism which are included in the design of many board drop hammers.

**Cylinder Boring Machine:** Barrett Machine Tool Co., Meadville, Pa. This machine is adapted for either belt or motor drive. The table is 71 by 66 inches in size and the tail pedestal can be adjusted on the bed from 0 up to 60 inches. The boring bar is 8 inches in diameter and has a continuous feed of 60 inches in either direction. Rapid power traverse in either direction is provided and the method of control is such that it may be handled with one hand when moving through short distances.

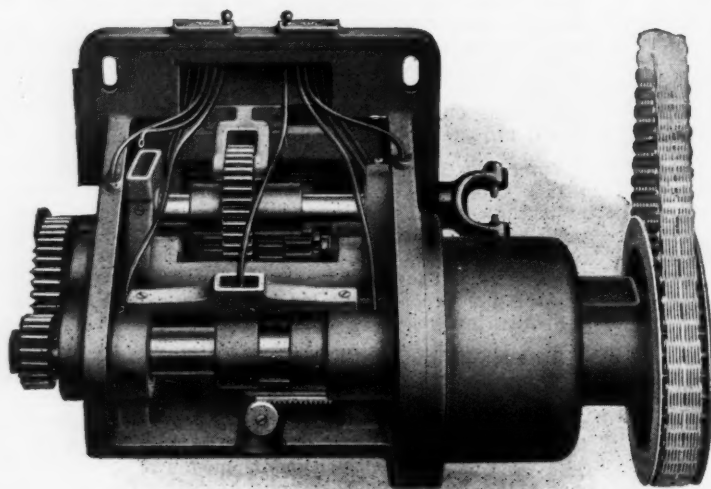
**Spur Gear Testing Machine:** Gleason Works, Rochester, N. Y. A machine equipped with power drive and a wood lined brake which may be adjusted for testing gears under various loads. The sliding heads of the machine are square gibbed and the spindle bearings are bronze bushed. The adjustment of the center distance is provided by a screw and handwheel graduated to 0.001 inch. The maximum distance between centers is 9 inches and the minimum distance  $1\frac{1}{4}$  inch. The machine swings 16 inches.

**Index Centers:** Fred C. Dickow, 33 S. Desplaines St., Chicago, Ill. A set of universal index centers which swing 10 inches in diameter. The centers are made of tool steel, hardened and ground, and the spindle is equipped with a clamping device by means of which it can be locked during the cutting operation. This is the means of relieving the worm, wormwheel and index pin of all strain. The index plates provide for obtaining any number of divisions up to 50 and all even numbers from 50 to 100.

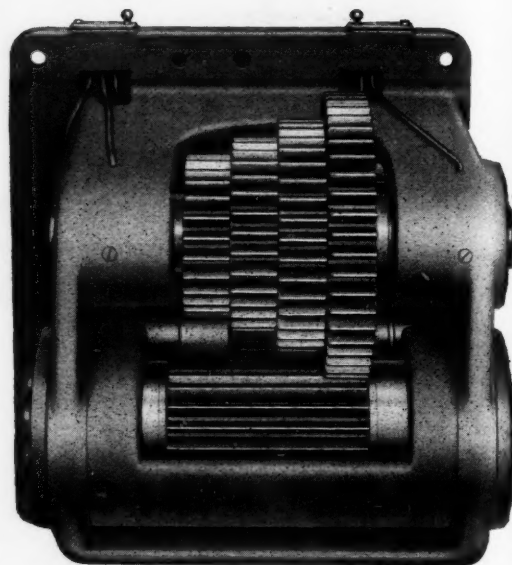
**Nut Lock:** O. K. Nut Lock Co., Providence, R. I. A nut lock consisting of a corrugated washer and a nut which is corrugated on the under side. The threaded section of the bolt has a slot in it which holds a split washer against turning. When the nut is screwed down, a lug on one end of the split washer engages with the corrugations in the washer, while a similar lug on the other end of the split washer engages the corrugations on the under side of the nut. In this way, the nut is prevented from turning.

**Blueprint Machine:** Revolute Machine Co., 417 E. 93rd St., New York City. A continuous blueprinting machine in which the light is obtained from two mercury vapor lamps. These lamps are contained in a revolving glass cylinder, and the blueprint paper passes between a belt and the tracing, the tracing being in contact with the glass cylinder. Printing is done while the paper revolves through three-fourths of a revolution of the cylinder. The machine is 32 inches wide and is designed for offices where the demand for blueprints is not large.

# Length of Service is Determined by



Interior of Feed Case



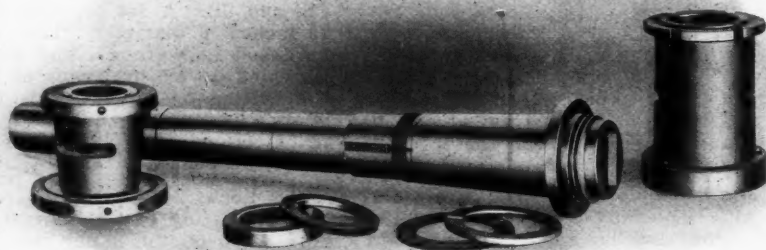
Interior of Speed Case

Bearings—the life of the Milling Machine—are easily overlooked in the general discussion of operating features and productive capacity when buying. Most of them are out of sight, yet their distribution, size and quality are the points which really determine length of service and the return on the investment.

The three cuts show examples of our attention to maintenance of accuracy in designing bearings. Note the heavy shafts mounted in massive housings in the feed and speed cases above. Each shaft is firmly supported close to the point of pressure.

Principal shafts are hardened and ground. All shafts run in long bronze boxes. The oiling system is simple and thoroughly efficient.

The spindle runs in long, heavy phosphor bronze boxes firmly mounted in thick walls. Simple and efficient means are provided to compensate for wear—front spindle bearing tapered, wear taken up by drawing spindle into taper—rear spindle bearing straight, wear taken up by clamping split box concentrically. End thrust taken by heavy hardened steel and babbitt washers.

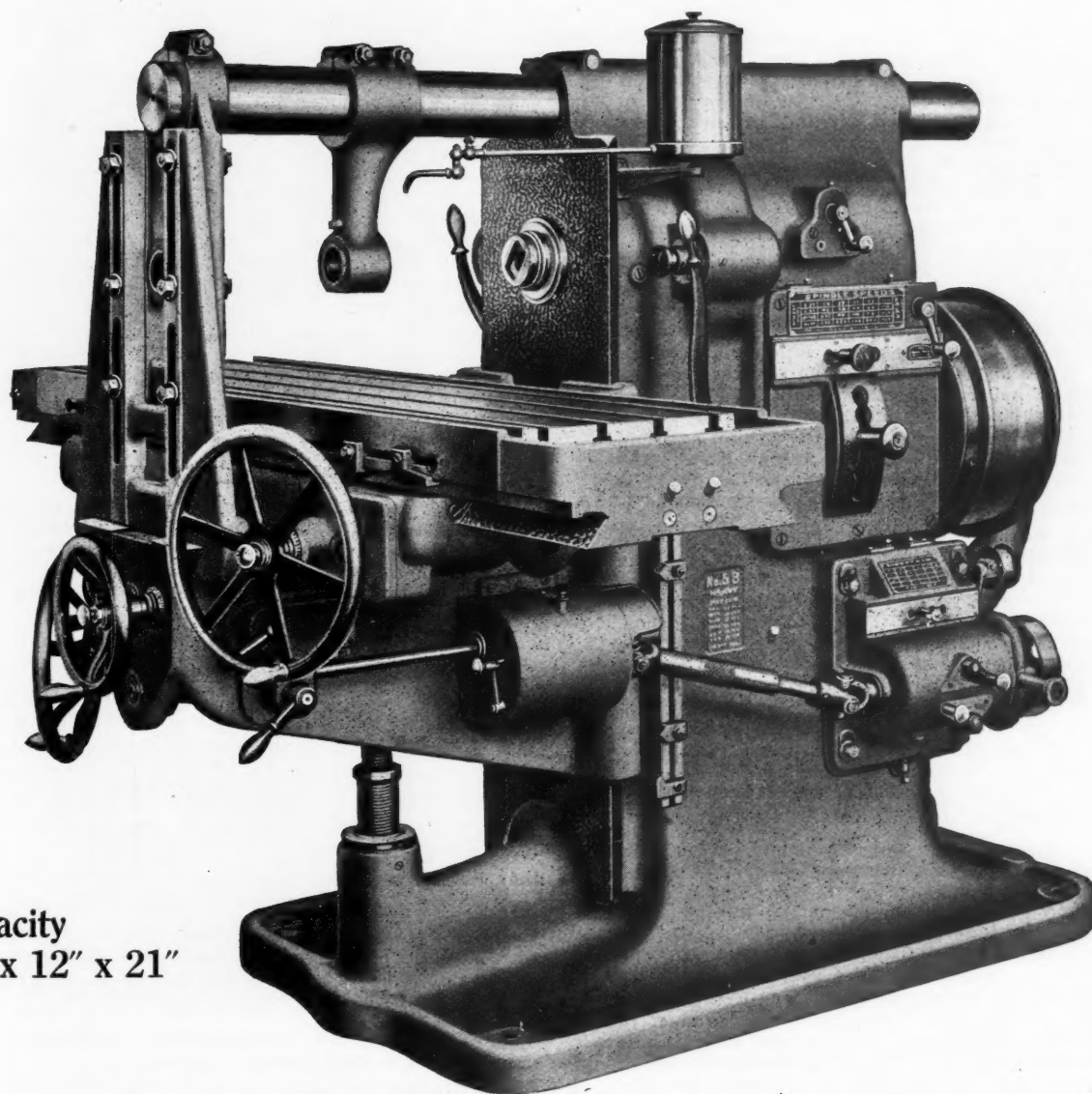


## BROWN & SHARPE MFG. CO., P

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419 University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O.; Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

# ed by the Durability of Bearings



Capacity  
50" x 12" x 21"

Observe the ample proportions of the flat bearing surfaces on the **No. 5-B Heavy Plain Milling Machine**. Wide bearings directly beneath the points of greatest stress on the table prevent springing under heavy cuts. The knee slide extends to the top of the frame, stiffening the column and reducing to a minimum the possibility of any spring in the spindle bearings.

Notice the long bearings of the knee on the column, the massive appearance of all parts, the stiff support for the cutter arbor. And coupled with these features is abundant power for handling the heavy jobs found in machine tool, engine and railroad shops.

In our line of **39 different sizes and styles** of Milling Machines there are just the right machines for your purpose.

## PROVIDENCE, R. I., U. S. A.

**CANADIAN AGENTS:** The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Ottawa, Winnipeg, Calgary, Vancouver, St. John.  
**FOREIGN AGENTS:** Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a/M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

Read page 67

**Vertical Slotting and Milling Attachments:** Rockford Milling Machine Co., Rockford, Ill. These attachments are driven by a geared connection at the back end of the spindle. When it is desired to use the milling machine for standard operations, the intermediate gear of the attachment is readily removed, thus disconnecting the drive. The distance from the face of the column to the center of the spindle of the vertical attachment is 7 inches and the maximum distance from the nose of the spindle to the top of the table, 19 inches. The slotting attachment has a stroke of  $2\frac{1}{2}$  and  $3\frac{1}{2}$  inches.

**Electric Furnace Regulator:** Thwing Instrument Co., 445 N. 5th St., Philadelphia, Pa. A special type of automatic temperature recorder and regulator for use on electric furnaces. This instrument is particularly adapted for use in connection with furnaces employed for the heat-treatment of small tools, springs and similar parts. It can also be used in connection with an oil or gas fired furnace. A furnace equipped with this regulator enables the temperature to be held within close limits, thus providing for treating the work at exactly the right temperature and having all of the parts of uniform hardness.

**Barrel Welding Machine:** Davis-Bournonville Co., Jersey City, N. J. A machine for welding the side seam of barrel bodies made of steel plates  $\frac{3}{32}$  inch in thickness. The edges to be welded are brought together without lap and no metal is added in making the weld. Two torches are employed, one of which acts outside and one inside the barrel as they are fed over the work. A duplex work arm is provided which enables one barrel to be in the working position, and while this barrel is being welded a second barrel may be mounted in the clamps on the other arm, so that there is practically no loss of time between successive operations.

**Electric Buffing Machine:** United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. In the May, 1913, number of MACHINERY, two sizes of motor-driven grinding machines built by the United States Electrical Tool Co., Cincinnati, Ohio, were illustrated and described. Since that time this company has brought out a line of six sizes of buffing machines, which are of similar design except for the fact that the length of the spindles has been extended to provide the necessary clearance for buffing, and that the speed is increased to the required figure. These machines are made in  $\frac{1}{4}$ ,  $\frac{1}{2}$ , 1, 2, 3 and 5 horsepower sizes. Motors may be provided for use on 220-440 volt, 60-cycle, two or three phase alternating current, or for 110-220 volt, direct current.

**Screw Plates:** Russell Mfg. Co., Greenfield, Mass. To meet the demand for a simple, quick opening die for threading bolts by hand, this company has brought out a quick opening die screw plate. It is similar to the Russell Style B screw plate, except that it may be quickly opened by means of a small lever, thus disengaging the die from the work. This means a considerable saving of time, as when the thread has been cut to the required length the die is opened and lifted off the work. Another recent product of the Russell Mfg. Co. consists of a full mounted screw plate. This plate is evolved from the original adjustable die which was invented in 1871. The die may be adjusted to compensate for wear, or to make a tight or loose fit for the bolt and nut, by first loosening two outside binding screws and then adjusting two taper headed screws which control the position of the cutters. After the adjustment has been made, the binding screws are again tightened and the tool is ready for use. The dies in this plate and in all other Russell plates are made double, so that they will cut from either face.

**Manufacturing Milling Machine:** Potter & Johnston, Pawtucket, R. I. One of the most striking features of this machine consists of two parallel work tables. One of these tables is located under the cutter arbor while the other is out at the front of the machine. By this arrangement the cutter may be operating on the work on one table, and while this operation is in progress the mechanic may be setting up work on the other table. In this way, the time between operations is cut down to a trifle more than the time required to index the table. The work tables are mounted on a circular turntable which brings them alternately into the loading and cutting positions, and locates them accurately. The machine spindle is carried on a vertical slide on the column upon which its position may be adjusted. The column, in turn, is carried on a horizontal slide. A rigid arbor support is provided. There are twelve spindle speeds and sixteen independent feeds. The available spindle speeds are 20, 25, 30, 37, 44, 54, 66, 80, 99, 121, 147 and 180 revolutions per minute. The feeds which are available are  $\frac{3}{4}$ ,  $\frac{7}{8}$ ,  $\frac{11}{16}$ ,  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{3}{8}$ ,  $\frac{1}{8}$ ,  $\frac{1}{16}$ ,  $\frac{3}{16}$ ,  $\frac{1}{8}$ ,  $\frac{1}{16}$ ,  $\frac{3}{32}$ ,  $\frac{1}{32}$ ,  $\frac{1}{64}$ ,  $\frac{1}{128}$  inches per revolution. The feed changes are independent of the changes of spindle speed.

## PERSONALS

Otto Abrahamsen, treasurer of Beaudry & Co., Inc., Boston, Mass., has gone to Europe on a three months' trip.

R. C. Cole has joined the staff of the pneumatic tool department of the Ingersoll-Rand Co., and has been stationed at the Chicago office.

Ralph E. Flanders, general manager of the Jones & Lamson Machine Co., Springfield, Vt., sailed May 9 on the *Olympic* for a short business trip in Europe.

M. E. Towner has been appointed special representative of the Whitman & Barnes Mfg. Co., Akron, Ohio, with office at 113 N. Second St., St. Louis, Mo.

W. S. Dickson, representing the Cincinnati Planer Co., and the Acme Machine Tool Co., both of Cincinnati, Ohio, sailed for Europe the latter part of May for a business trip.

R. E. Ellis, formerly with the Chicago office of Manning, Maxwell & Moore, Inc., is now sales manager for the Steinle Turret Machine Co., Madison, Wis.

H. M. Waite, manager of the city of Dayton, Ohio, addressed the Engineers' Club of Cincinnati and the Cincinnati section of the American Society of Mechanical Engineers, Thursday evening, May 21, on "Municipal Government under the City Manager Plan."

A. H. Boyd, who has been with the Fort Wayne Electric Works of the General Electric Co. since 1898 and for the last four years has been acting as manager of the company's Philadelphia office, has resigned to become general manager and treasurer of the Santo Mfg. Co., Philadelphia, Pa.

\* \* \*

## OBITUARIES

W. G. Kirkaldy, a well-known British expert on the testing of engineering materials, died April 10, aged fifty-one years. He had contributed a number of papers to engineering societies recording the results of his investigations. He was a member of the firm of David Kirkaldy & Son, London.

\* \* \*

The Baldwin Locomotive Works has built a new type of articulated locomotive for the Erie R. R. which is known as the "triplex compound." It is a development of the Mallet articulated type in which the weight of the tender is made available for tractive purposes, a third engine being under the tender. The total weight of the unit is 853,000 pounds, and the tractive power is 160,000 pounds. It has twelve driving wheels on each side arranged in three groups of four wheels each. A pony truck in front and at the rear makes the total number of wheels supporting the unit twenty-eight. The design, originated by G. R. Henderson, consulting engineer of the Baldwin Locomotive Works, makes 89 per cent of the total weight of engine and tender available for traction effort. High pressure, superheated steam is supplied to the high-pressure cylinders of the center unit. One of these cylinders exhausts to the pair of low-pressure cylinders in the rear and the other high-pressure cylinder exhausts to the pair of low-pressure cylinders in front. The firebox is nine by ten feet, the grate surface being 90 square feet. The tube heating surface is 6418 square feet and the total equivalent heating surface including tubes, firebox, combustion chamber and superheater is 9262 square feet.

\* \* \*

The liner *Laconia*, of the Cunard Line, which was built three years ago, was provided with Frahm's anti-rolling tanks, and it has been shown beyond doubt that in the case of this 18,000-ton steamer the rolling of the vessel has been reduced, on an average, 60 per cent. The success with the *Laconia* in this respect has induced the Cunard Co. to provide the 50,000-ton *Aquitania*, just being completed, with anti-rolling tanks.

## STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Business Manager, Alex. Luchars, President	" " " " "
Managers, M. J. O'Neill, General Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock:—	
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
H. L. Brown	" " " " "
Erik Oberg	" " " " "

There are no bondholders, mortgagees, or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of March, 1914.

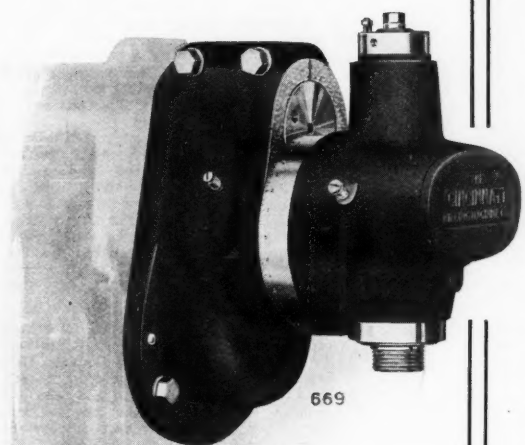
HARRY B. HEALEY,

Notary Public No. 84, Kings County,

Certificate filed in New York County No. 74.

(My commission expires March 30, 1916.)

(SEAL)



## A Small Machine Shop

equipped with a

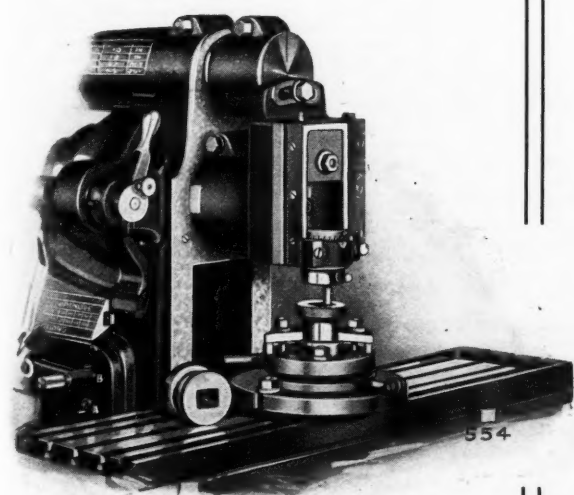
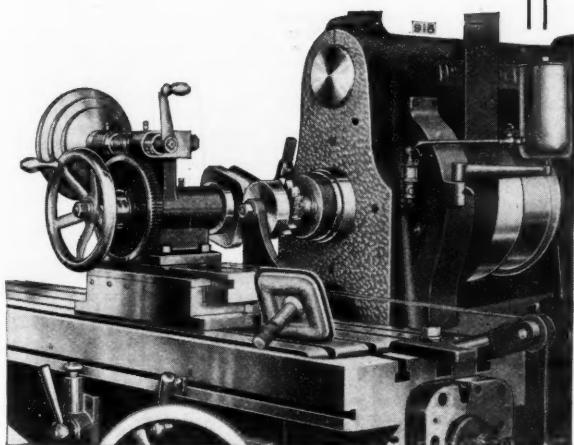
# CINCINNATI UNIVERSAL Milling Machine

These three attachments and a sensitive drill can do every variety of milling—end, side and surface—a general line of die sinking, profiling and engraving, broaching, shaping, slotting, mill cams of every description, cut spur, bevel and spiral gears; in short, handle nearly everything within the range of the machine—rapidly and accurately.

Instead of tying up money in a lot of miscellaneous tools, the proprietor of a small shop should first buy a *Universal Milling Machine*.

No matter whether your shop is small or large, let us tell you how and why the prominent firms in America and Europe use Cincinnati Millers.

SEND FOR OUR NEW CATALOG



**The Cincinnati Milling  
Machine Company**  
CINCINNATI OHIO, U. S. A.

## COMING EVENTS

June 4.—Joint meeting of the Engineers' Club of Cincinnati, and the Cincinnati section of the A. S. M. E. in McMicken Hall, University of Cincinnati, Cincinnati, Ohio, addressed by a representative of the National Tube Co. on the "Manufacture of Steel Tubes."

June 9-12.—Second convention of the National Association of Corporation Schools at Philadelphia, Pa. Arthur Williams, President, Irving Place and 15th St., New York City.

June 10-12.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

June 16-19.—Spring meeting of the American Society of Mechanical Engineers, Minneapolis and St. Paul, Minn. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

June 30-July 4.—Annual meeting of the American Society for Testing Materials, Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Warburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 15-22.—Second International Congress of Consulting Engineers, to be held in Berne, Switzerland.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

## SOCIETIES, SCHOOLS AND COLLEGES

University of South Carolina, Columbia, S. C. Catalogue 1913-1914.

Hebrew Technical Institute, 34 and 36 Stuyvesant St., New York City. Catalogue for 1914.

University of Nevada, Reno, Nev. Proceedings of the First Annual Industrial Safety Conference, held at the University of Nevada, January 26-27, 1914.

Columbia University, New York City. The summer session of the university extends from July 6 to August 14, not from June 3 to September 23, as erroneously stated in the May number of MACHINERY.

Technical League of America, 74 Cortlandt St., New York City, has issued a manifesto to the salaried members of the engineering profession which entreats them to unite to obtain that economic and social standing to which they are entitled by the services they render. The manifesto will strike a responsive chord in the hearts of every designer, draftsman and engineer who appreciates what their professions are doing for the world at large.

University of Wisconsin, Madison, Wis. Bulletin of the summer school extending from June 22 to July 31. The law course and certain courses in the College of Agriculture last until August 28. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shop work and surveying. Copies of the bulletin can be obtained from F. E. Turneure, University of Wisconsin, Madison, Wis.

National Association of Corporation Schools, 124 W. 42nd St., New York City. Bulletins 1 and 2, containing "Report of Sub-Committee on Manufacturing and Transportation," by Mark B. Hughes; "Engineering Schools of Electrical Manufacturing Companies," by Dr. Charles P. Steinmetz; "Methods of Selecting Men in Business," by F. C. Henderschott; the president's address delivered at the banquet of the organizing convention, by Arthur Williams; "National Cash Register Schools for Salesmen," by R. H. Grant; and "Reasons for the Shortage of Skilled Mechanics," by A. F. Bardwell.

## NEW BOOKS AND PAMPHLETS

American Water Works Association Proceedings, 1913. 749 pages, 6 by 9 inches. Published by the Association, John M. Diven, secretary, Troy, N. Y.

Testing the Hardness and Durability of Metals. Second edition. 40 pages, 6 by 9 inches. 19 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Safety and Sanitation. By Magnus W. Alexander, an address delivered at the seventeenth annual convention of the National Founders' Association, New York City, November, 1913.

Official Record of the First American National Fire Prevention Convention, held at Philadelphia, Pa., October 13-18. Compiled by Powell Evans, Philadelphia, Pa. 541 pages, 6 by 9 inches.

Critical Ranges A2 and A3 of Pure Iron. By G. K. Burgess and J. J. Crowe. 100 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 213 of the Bureau of Standards, Vol. 10.

Electric Switches for Use in Gaseous Mines. By H. H. Clark and R. W. Crocker. 36 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 68.

The Use of Iowa Gravel for Concrete. By T. R. Agg and C. S. Nichols. 31 pages, 6 by 9 inches. 9 illustrations. Published by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin 34 of the Engineering Experiment Station, Good Roads Section.

The Sampling and Examination of Mine Gases and Natural Gas. By George A. Burrell and Frank M. Seibert. 116 pages, 5½ by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 42.

The Utilization of Petroleum and Natural Gas in Wyoming. A preliminary report by W. H. Calvert. With a discussion of "The Suitability of Natural Gas for Making Gasoline," by George A. Burrell. 23 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical paper 57.

Caspar's Technical Dictionary of the English and German Languages. 272 pages, 4½ by 6 inches. Published by C. N. Caspar Co., Milwaukee, Wis. Price, \$1 net.

This dictionary comprises the most important words and terms employed in technology, engineering, machinery, chemistry, navigation, shipbuilding, electro-technics, "automobilism," aviation, etc. It is in two sections—English-German and German-English. The important technical words and phrases which have come into general use during the last decades are included.

Harper's Gasoline Engine Book. By A. Hyatt Verrill. 292 pages, 5½ by 7½ inches. Illustrated. Published by Harper & Brothers, New York City. Price, \$1.

The extensive and growing use of the internal combustion motor has made it an object of general interest. This work, intended for boys and young people generally, treats of the gas engine, motor anatomy, marine and stationary motors, vehicle motors, troubles and repairs. It deals with both the two-stroke cycle and four-stroke cycle types and takes up construction features in detail.

Electric Furnaces for Making Iron and Steel. By Dorsey A. Lyon and Robert M. Keeney. 142 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of Interior, Washington, D. C., as Bulletin 67.

The bulletin is divided into two parts, the first treating of the electric furnace in pig-iron manufacture and the second on the electric furnace in steel manufacture. The growing importance of the electric furnace in iron and steel production should make this bulletin of unusual interest and value to iron and steel makers.

Harper's Aircraft Book. By A. Hyatt Verrill. 245 pages, 5½ by 7½ inches. Illustrated. Published by Harper & Brothers, New York City. Price, \$1.

This work, intended for boys and others interested in making model aeroplanes, tells why aeroplanes fly, how to make models, and other interesting facts regarding heavier-than-air machines. It treats of motor-propelled and gliders, or non-propelled aeroplanes, hydro-aeroplanes and flying boats, the uses of the aeroplane, etc. Being profusely illustrated, the text should be readily understood by those who wish to follow the directions for making models.

Where and Why Public Ownership Has Failed. By Yves Guyot. Translated from the French by H. F. Baker. 459 pages, 5 by 7½ inches. Published by the MacMillan Co., New York City.

The work is divided into four parts as follows: Public and Private Trading Operations; Financial Results of Government and Municipal Ownership; Administrative Results; Political and Social Consequences of Public Operation. The author discusses the conditions of municipal activity in the United Kingdom, the United States, Germany, Russia, France, Austria-Hungary, Italy, Denmark, Switzerland, Netherlands, Belgium and Sweden.

Metal Coloring and Finishing. 39 pages, 6 by 9 inches. 14 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 123 of MACHINERY's Reference Books, and deals with the methods of producing colors on iron, steel, copper, bronze, brass and aluminum, together with chapters on burnishing metals, including both lathe burnishing and ball-burnishing processes. The book deals with a subject on which no information is generally available except in large volumes containing formulas and recipes for all kinds of purposes. It gives descriptions of many processes for obtaining colors on metals and will be found valuable by those who are interested in this class of work.

Telephone Construction, Installation, Wiring, Operation and Maintenance. By W. H. Radcliffe and H. C. Cushing, Jr. 223 pages, 4 by 6½ inches. 132 illustrations. Published by Norman W. Henley & Son, New York City. Price, \$1.

The first edition of this work was published in 1908. Considerable new matter has been added to the second revised edition to bring the work up to date. The work begins with the first principles, the assumption being that the reader knows nothing of telephony. It deals with the subject so thoroughly, however, that not only the amateur,

but the wireman, the engineer and the contractor will find it useful. It treats of the construction, operation and installation of telephone instruments, inspection and maintenance of telephone instruments, testing telephone line wires and cables, wiring and operations of special telephone systems, etc.

Cold-heading. By Chester L. Lucas. 44 pages, 6 by 9 inches. 47 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 119 of MACHINERY's Reference Books. It deals with the machines, methods and tools used for the cold-heading of screws, rivets and similar machine parts. The contents of the book are divided into three distinct parts: the first deals with principles of cold-heading, describing and illustrating the general methods employed; the second with cold-heading machines and operations, illustrating and describing the typical cold-heading machines manufactured and used in this country; and the third with cold-heading dies and tools, showing their construction and illustrating the methods used in making them. Mechanics will be particularly interested in this book, as it is the only one that has ever been published on the subject.

Machining Tapered and Spherical Surfaces. By Albert A. Dowd. 43 pages, 6 by 9 inches. 35 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

During the past year MACHINERY has published a number of valuable articles by the author of this book, relating to tools and devices used for machining operations. Two of these, describing taper boring and turning attachments and the machining of convex and concave surfaces, have been given permanent form in this book, which is No. 121 in MACHINERY's Reference Books. The book shows a great number of devices illustrated by carefully made line-engravings and accompanied by concise descriptive text. All of the devices shown are taken from actual practice and have been designed for commercial purposes. The range covered is very extensive, passing from the simple to the complex devices used for the purposes mentioned. Tool designers, shop foremen, and those responsible for production in general will find much valuable material in this book.

National Association of Corporation Schools. Report of First Annual Convention including papers and discussions presented at Dayton, Ohio, September 16-19, 1913. Executive office, Irving Place and 15th St., New York City.

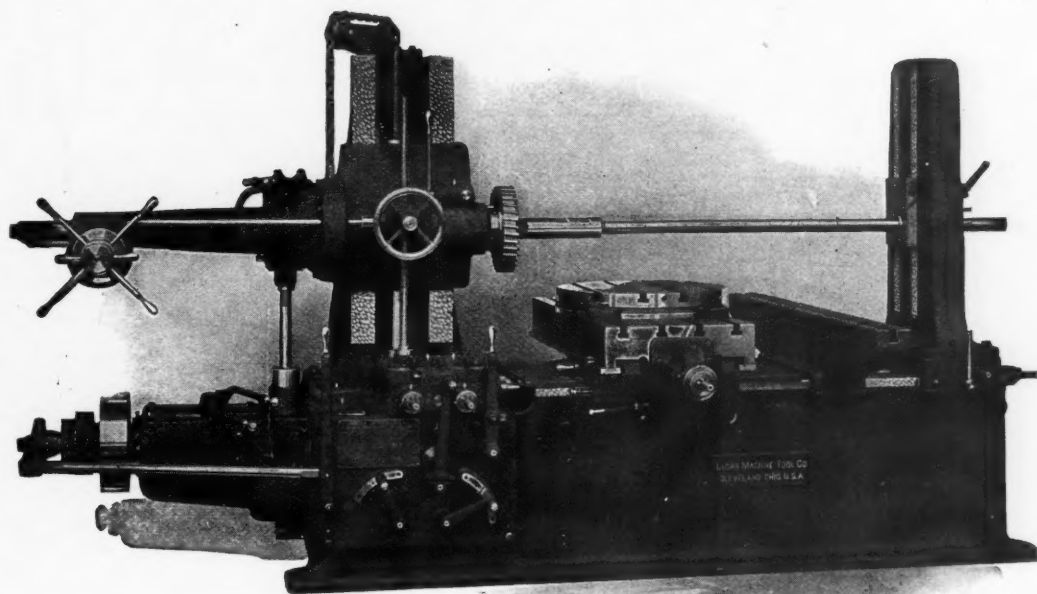
The National Association of Corporation Schools movement differs from any other in that it aims to carry specialized and general training to young men and women after they have actually entered upon their business or industrial careers. The work of the association does not enter into any of the established continuation schools, but is confined primarily to the establishment of what is practically a continuation school in industry, endeavoring through specialized training to replace the former, and now practically obsolete, apprenticeship training; and to bring as much as possible of a more general training and education to the industrial workers of our country. The membership of the association now includes nearly 150 in all classes, including thirty-two industries employing in the neighborhood of a million men and women.

Business Administration. By Edward D. Jones. 275 pages, 5 by 7½ inches. Published by Engineering Magazine Co., New York City. Price, \$2.

The Engineering Magazine Co. has published a number of well-known books on works management and this work is the latest addition to the list. Prof. Jones assumes that success in dealing with men and affairs depends upon certain laws which can be discovered in the work of successful administrators, but that the rules and methods followed by masters of business and finance are usually not open to investigation. The leaders in statecraft, war and science, however, are figures whose careers and practice are fully recorded and open to analysis. In the study of history and the biography of warriors, diplomats and scientists, he has found what he considers to be the elementary rules of success. In short, Prof. Jones derives the principles, motives and actions of successful business men by studying the careers of successful public men. The contents are as follows: The Rise of a New Profession; The Utility of the Study of History; Military History; Administrative Principles; The Pioneers of Science; System-makers of Science; The Application of Science; The Principles of Mental Efficiency; History of the Gentleman Administrator; Methods of the Gentleman Administrator; Ideals of the Gentleman Administrator.

Compressed Air. By Theodore Simons. 173 pages, 6 by 9 inches. Illustrated. Published by the McGraw-Hill Book Co., New York City. Price, \$1.50.

This treatise on the production, transmission and use of compressed air treats of the natural laws and physical principles concerned. The endeavor has been made to produce a work suitable for the average technical student who has a sound knowledge of the elements of algebra, physics and mechanics. The contents comprise Production of Compressed Air; The Behavior of Air Undergoing Compression and Under the Application of Heat; The Compression of Air in Air Compressors; Theory of Air Compression; Clearance, Volumetric Efficiency, Capacity, Speed, Mechanical Efficiency of Compressors; Two-stage and Multi-stage Compressions or Compound Compression; Effect of Altitude on Air Compression; The Compressed Air Indicator Card; Cooling Water Required in Compression—Efficiency of Compressor Plant—Air Compressor Ex-



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plosions; The Transmission of Compressed Air; Dimensions of Pipe Lines for Conveying Compressed Air; The Use of Compressed Air; Theory of Air Engines; Effective Heat Losses; Internal or Intrinsic Energy of Air; The Efficiency of a Compressed Air System; Reheating of Compressed Air; Air Compressors and Accessories; Examples of Modern Air Compressors of the Reciprocating Type; Important Mechanical Features of Air Compressors; Compressor Accessories.

**Steam Turbines.** By James A. Moyer. 376 pages, 6 by 9 inches. 225 illustrations. Published by John Wiley & Sons, New York City. Price, \$3.50.

The first edition of Prof. Moyer's work was published in 1908. The additions made in the 1914 edition of this favorably known work on steam turbines have been mainly in the line of new applications. The chapter on low pressure turbines has been rewritten to include the latest developments and applications. The real important developments of the last few years have been in the construction of increasingly large sizes of steam turbines. The author mentions that the largest turbine generator now ready for installation is rated at 35,000 kilowatts, which is to be compared with a maximum size of 14,000 kilowatts of only three years ago. The contents by chapter heads are: The Elementary Theory of Heat; Nozzle Design; Steam Turbine Types and Blade Design; Mechanical Losses in Turbines; Method for Correcting Steam Turbine Tests; Commercial Types of Turbines, including De Laval, Parsons, Westinghouse, Allis-Chalmers, Curtis, Rateau, Wilkinson, Zoelly, Sturtevant, Riedler-Stumpf, Kerr, Terry, etc.; Governing Steam Turbines; Low-pressure (Exhaust) Turbines; Mixed Pressure Turbines; Bleeder or Extraction Turbines; Marine Turbines; Tests of Turbines; Steam Turbine Economics; Stresses in Rings, Drums and Disks; Gas Turbines; Electric Generators for Turbines.

### NEW CATALOGUES AND CIRCULARS

**George P. Clark Co., Windsor Locks, Conn.** Bulletin AC giving dimensions, prices, etc., of wheels and casters.

**H. Bickford & Co., Lakeport, N. H.** Leaflets illustrating boring and turning mills with motor drive and rapid power traverse, respectively.

**Percy Pitman, 3 Wilcott Road, Acton, London, W., England.** Circular of the Pitman hydraulic governor for controlling the speed of water turbines, impulse wheels, etc.

**Lutz-Webster Engineering Co., Philadelphia, Pa.** Leaflet giving prices of the various sizes of compression wrenches, ratchets and bolt and nut sockets made by this company.

**Sprague Electric Works of the General Electric Co., 531 W. 34th St., New York City.** Circular 905 on Sprague electric hoists, illustrating a large number of designs suited to all kinds of hoisting service.

**Millers Falls Co., Millers Falls, Mass.** Pamphlet describing the Nos. 99, 99A, 100, 190, 199A, 200, 2100 and 2200 breast drills of this company's manufacture. Each style of drill is illustrated and its features briefly described.

**David Maydole Hammer Co., Norwich, N. Y.** Catalogue on the Maydole hammers, which are forged from solid crucible cast steel. The specifications for these hammers are printed in English, French, German and Spanish.

**C. M. Smillie, 130 E. Larned St., Detroit, Mich.** Circular of Smillie compensating turret chuck or drill holder for Fox lathes, turret lathes and screw machines. The chuck is made in three sizes, taking drills from No. 42 to 1 inch.

**Laidlaw-Dunn-Gordon Co. (International Steam Pump Co., successor), Cincinnati, Ohio.** Bulletin L-523-A, treating of the Cincinnati gear duplex Corliss steam driven air compressors, classes WA and XA. 24 pages, 6 by 9 inches.

**Fred C. Dickow, 33 S. Desplaines St., Chicago, Ill.** Leaflets illustrating double friction clutch countershaft and 10-inch universal index centers. The countershaft is provided with hollow set-screws which should commend it to those interested in "Safety First."

**Ph. Bonvillain & E. Ronceray, 9-11 Rue des Envierges, Paris, France.** Catalogue 6 in French on molding machinery, 104 pages, 8½ by 10½ inches, containing descriptions of the line of up-to-date molding machines and accessories manufactured by this company.

**Carroll-Jamieson Machine Tool Co., 257 Davis St., Batavia, Ohio.** Bulletin on the Carroll-Jamieson "selective" sliding gear, single-belt drive 14-inch tool-room manufacturing lathe, illustrated. This lathe has a headstock designed to meet the demand for rapid production.

**Lumen Bearing Co., Buffalo, N. Y.** Booklet entitled "Bronze Alloys and Babbitts." The data given for each alloy is classified separately for a test bar cast in a chill and for a bar cast in sand; it includes tensile strength, elongation, Brinell hardness and specific gravity.

**Diamond Clamp & Flank Co., Richmond, Ind.** Circular of an "air spreader" or fan for use in machine shops, factories, etc. The fan is mounted in a bracket that is secured to the ceiling, and is driven by a belt from the line shaft. A clutch is provided for throwing it in or out of action.

**Baker Bros., Toledo, Ohio.** Catalogue on Baker heavy pattern high-speed drills built in 5-inch, 4-

inch, 3-inch and 2½-inch capacities. Illustrations of these machines with their various attachments are shown. The 1-inch by 6-inch automatic drill built by the Baker Bros. is also illustrated.

**Consolidated Expanded Metal Companies, Architects Bldg., New York City.** Pamphlet illustrating the use of "Steelcrete" guards for machine tools, line shafts, chain drives, punch presses, stairways, etc. Expanded metal is well suited for machine guards, being light, strong and durable.

**Monarch Mfg. Co., Dayton, Ohio.** Circular of the Dayton welding and decarbonizing plants for use in repair shops, garages, etc. The company furnishes a welding outfit for \$75 and a decarbonizing, welding and cutting outfit for \$115. Directions are given for building acetylene generators at small cost.

**Mesta Machine Co., Pittsburg, Pa.** Catalogue O, giving the advantages of rope drives, among which may be mentioned smooth continuous action, low cost and high efficiency, noiselessness, freedom from shocks, etc. The catalogue also contains charts showing the length of life and horsepower transmitted by manilla ropes.

**Brown Hoisting Machinery Co., Cleveland, Ohio.** Catalogue D 1914, treating of "Brownhoist" tram-rail systems, trolleys and electric hoists. A number of interesting installations of Brown hoists are shown, and the specifications are conveniently arranged in tabular form, capacity, dimensions, prices, etc., being given.

**American Swiss File & Tool Co., 24 John St., New York City.** Circular of a fourteen-inch file with a new cut called "Wavecut." This file removes metal in curled shavings instead of the ordinary granular filings. It has diagonal rows of cutting edges which give the file a wavy appearance that suggested the trade name, "Wavecut."

**Sleeper & Hartley, Worcester, Mass.** Bulletins 277 and 280 on spring hooking machines and spring coiling machines, respectively. The spring hooking machines produce any desired form of hook or loop on either right- or left-hand springs without waste of stock. The spring coiling machines produce either extension or compression springs.

**Ransom Mfg. Co., Oshkosh, Wis.** Bulletin SD1, showing the application of Ransom safety devices to abrasive wheels. These devices include steel and cast-iron wheel guards of the open and enclosed types, safety flanges, safety nuts, and the Ransom patent speed controller which obviates the possibility of over-speeding the wheel.

**Hogson & Pettis Mfg. Co., New Haven, Conn.** Catalogue and price list 10 C of "Sweetland" lathe chucks, comprising combination chucks, universal chucks, car-wheel chucks, independent chucks, geared scroll chucks, planer chucks, drill chucks, etc. Information is also contained on the mounting and care of chucks, repairs and special chucks.

**C. & E. Mfg. Co., Marshalltown, Iowa.** Leaflet entitled "How do you do without the Marshalltown?" setting forth the advantages of the "Marshalltown" wrench—a ratchet wrench with only three working parts. Four detachable jaws are furnished for use on ¾, 7/16, ½ and 9/16 inch nuts, and in addition there is one alligator jaw in the handle.

**Munning-Loeb Co., Matawan, N. J.** Bulletin 500 of plating and industrial brushes, comprising circular brushes, horse hair brushes, camel hair brushes, metal wire and cotton brushes, crinkled brass or steel wire brushes, hand polishing and scratch brushes, scouring brushes, etc. This line of brushes is made for electroplaters, buffers and other manufacturers of finished metal goods.

**Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.** Circular E-1 of the new "Thor" electric drill equipped with universal motor for alternating and direct current, made in four sizes, the small size having capacity from 0 to ¼ inch; the second, 0 to 5/16 inch; the third, 0 to ¾ inch and the fourth, ¾ to 9/16 inch. These drills are equipped throughout with ball and roller bearings.

**Betts Machine Co., Wilmington, Del.** Catalogue 2614 on horizontal boring and drilling machines and attachments. 20 pages, 6½ by 9½ inches. The attachments that can be furnished for these machines at the desire of the purchaser are: additional circular table, extra facing head to facilitate machining both ends of a casting at the same time, threading attachment, power feeds to tables and electric drives.

**Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.** Bulletin No. 61 on electric traveling cranes. 39 pages, 8½ by 11 inches. This book gives a complete description of the Shepard electric cranes and their various parts. Some of the basic features are: the balanced drive, complete enclosure of high-speed gearing, system of load brakes, and lubrication. A large number of installations of Shepard electric cranes are shown.

**Van Dorn & Dutton Co., gear specialists, Cleveland, Ohio.** Booklet treating of "V. D. & D." railway and mill motor gears and pinions. The gears are made from open-hearth steel castings in both solid and split types, with the exception of the forged or rolled gears which are furnished in the solid type only. Extreme care is taken both in the selection of material and in the manufacture of these gears.

**Fitchburg Grinder Co., Fitchburg, Mass.** Circular of the Fitchburg "Six-Fifteen" cylindrical grinding machine, styles A and B. The machine is of heavy proportions, being of 2- by 16-inch wheel capacity. It was designed especially to meet the demands for a simple machine suitable for grinding short cylindrical pieces in large quantities. Style A has an automatic traverse while style B is provided with hand traverse only.

**Nazel Engineering & Machine Works, 4043 N. 5th St., Philadelphia, Pa.** is issuing the "Nazel Hammer Book," which contains complete information concerning the Beche and Nazel hammers. These hammers are built in six sizes for either belt or motor drive. The Nazel-Beche hammer works on the same principle as the Beche hammer, but has a larger capacity and greater die area. The line of speed hammers produced by this company is also illustrated.

**Oster Mfg. Co., 2107 E. 61st St., Cleveland, Ohio.** Booklet entitled "Actual Pipe-Threading Experiences—II" containing information on average working times of Oster pipe-threading machines and showing installations of these machines in various parts of the country. All parts of Oster pipe-threading machines are standardized and interchangeable. The "facts and figures from the day's work" will be of much interest to those employing this class of machinery.

**Gleason Works, Rochester, N. Y.** Gear planer catalogue, 48 pages, 6 by 9 inches. This book includes descriptions and specifications of generating bevel gear planers (fully automatic), forming bevel gear planers (fully automatic), combination bevel and spur gear planer (semi-automatic), sixteen-foot bevel gear planer, bevel gear tempering machine and bevel gear testing machine. Each of these types of machines is illustrated by excellent half-tone engravings. The last section of the book illustrates mandrels for use on these machines.

**National Machinery Co., Tiffin, Ohio,** is issuing a series of folders entitled "National Forging Machine Talks." No. 2 takes up the bed frame as a potent factor in the efficiency of the forging machine, pointing out the necessity of providing stiffness and rigidity in this part of the machine. The half-tone and line drawings illustrate the steel bed frame casting of the National heavy-pattern forging machine, showing the heavy under-ribbing and the improved form of gap which extends but one-third the depth of the bed.

**Harrington Machine Co., Erie, Pa.** Folder descriptive of "under" milling machines A and B. These machines derive their name from the fact that the cutter is mounted so as to be underneath the work, thus leaving the lines on the work always in plain view, the table being entirely unobstructed by spindle or housings. Type A is especially designed for milling trimming dies used in drop-forges and for all irregular open work. Type B is similar to A, but is much heavier and is not equipped with a tilting table.

**Herman Bacharach, 14 Wood St., Pittsburg, Pa.** Catalogue B descriptive of "Hydro" volume and pressure recorders, for measuring and recording the volume and pressure of gases. 16 pages, 6 by 9 inches. The velocity charts included will be found of value in determining the velocity of gases of any specific gravity. Some interesting curves obtained from "Hydro" volume meters are shown. These record the gas consumption of by-product coke ovens, the amount of blast furnace gas used for heating stoves and the amount of coke oven gas consumed in a steel mill.

**Cullman Wheel Co., 1339 Greenwood Terrace, Chicago, Ill.** Catalogue 9, 24 pages, 5½ by 8½ inches, giving price lists of sprockets for use with Coventry and Whitney noiseless chain. Noiseless chains and wheels are now being made in 8 and 10 millimeter pitches, to provide a light, compact and efficient drive. Tables of specifications giving dimensions, weight, strength, price, etc., of Coventry and Whitney noiseless chains of different pitches are among the material that will be of value to automobile manufacturers and others interested in this form of transmission.

**Heald Machine Co., 20 New Bond St., Worcester, Mass.** Catalogue illustrating the Heald line of internal cylinder, ring, and drill grinding machines and magnetic chucks. This catalogue was produced as a souvenir for the National Machine Tool Builders and National Metal Trades Associations' conventions, which probably accounts for the decided departure from the stereotyped style of machinery catalogue that it presents. The cover is light grey with silver lettering and deckled edges. The artistic touch is also shown in the arrangement of the type and cuts, the latter being printed on a fine grade of paper and pasted along the top edge to the japan stock used for the body of the book.

**Crescent Machine Co., Leetonia, Ohio.** New catalogue on Crescent wood-working machinery. 143 pages, 4 by 6 inches. This catalogue describes the Crescent bandsaws, special equipment, bandsaw blades, saw-tables, shapers, planers, matchers, surfacers, cut-off saws, disk grinders, wood-workers, etc. Special attention is called to the No. 101 to 112 "Universal" wood-worker illustrated and described on pages 108 to 125. This machine consists of a bandsaw, a jointer, saw-table, borer and shaper. Additional attachments may also be provided, adapting the machine for mortising, tenoning, making moldings, grinding tools, and sanding. Other new features include the remodeling of the 26 by 8 inch surfacer, which has now been equipped with variable friction feed, and improved fenders on bandsaws.

**Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.** Catalogue 3002-A, Section 3082 on motor-driven pumps, describing pumps of various kinds driven by electric motors. A number of installations of these pumps are shown. Tables are also included giving the frictional heat in wrought-iron pipe, horsepower for pumping, standard dimensions for pipe, and atmospheric pressures, equivalent heads and suction lifts. Leaflet 2364-A treats of Westinghouse electric direct-current Type K crane

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motors. These motors are designed for severe intermittent varying-speed service, where high starting torque is required, as for cranes, hoists, coke-charging machines, etc. Leaflet 3745 describes and illustrates the construction of Type I oil switches intended for use on direct and alternating-current series lighting circuits and for controlling inductive loads of small capacity. Leaflet 3512-A is descriptive of Westinghouse electric auto starters for squirrel cage motors equipped with overload relay.

**Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo.** Treatise on the Diesel engine, containing 112 pages, 6 1/4 by 9 1/4 inches, profusely illustrated. This book is an excellent example of typographical work which should interest users of power, especially those seeking economical engines for manufacturing plants. The work treats of the efficiency, economy, life, construction, operation and fuel of the Diesel engine. It is generally known that this type of internal combustion engine shows the highest efficiency of any heat motor, being from 32 to 35 per cent under favorable conditions. Non-condensing steam engines show an efficiency of 7 to 9 per cent and often less in many plants. Among the subjects included are: Dr. Rudolph Diesel, first American built Diesel engine, Diesel fuel consumption, efficiencies of various prime movers, life of the Diesel engine, construction, starting, operation, cycle of operations, combustion, fuel, advantages, representative installations, useful data, etc.

### TRADE NOTES

**Nelson Tool Co., Inc.,** formerly at 1883 Park Ave., New York City, has removed to 781-783 E. 142nd St., New York City.

**Norma Company of America** is now occupying its new offices in the U. S. Rubber Co. building, 1790 Broadway, New York City.

**Gun-crete Co., Chicago, Ill.,** has opened new offices in the McCormick Bldg. This firm specializes in cement-gun work for engineering and industrial structures. It makes a specialty of steel protection work, water- and fire-proofing, etc., by the cement-gun process.

**Buffalo Foundry & Machine Co., Buffalo, N. Y.,** announces that it has terminated its arrangement with H. E. Jacoby as its representative in New York City and vicinity. The company will now handle directly all the inquiries related to

vacuum apparatus, castings, patterns and machine work.

**Gem City Machine Co., Dayton, Ohio,** has purchased the machine shop and business of the late William U. Colthar of Springfield, Ohio. The company will design and build special machinery models, dies, tools, jigs, etc., and will enlarge the Springfield plant, which will be under the management of C. F. Gardner.

**Santo Mfg. Co., Philadelphia, Pa.,** announces the purchase of the patents and manufacturing facilities of the Keller Mfg. Co. The company will continue to manufacture the "Santo" vacuum cleaners. The business will be conducted under a new management, but the engineering and manufacturing organizations have been retained as heretofore.

**Van Dorn & Dutton Co., Cleveland, Ohio,** manufacturer of cut and planed gears, recently established branch offices at 1007 N. Alameda St., Los Angeles, Cal., and 515 Mission St., San Francisco, Cal. The representative in charge of the Los Angeles office is H. E. Borland, and of the San Francisco office, W. B. Wilson, district sales manager.

**Kelly Reamer Co., Cleveland, Ohio,** at its annual meeting April 18, re-elected the following officers and directors: W. E. Kelly, president and general manager; W. A. Calhoun, vice-president; H. J. Maxwell, secretary; O. H. P. Davis, treasurer; E. B. Jessup, T. A. Torrance and George Bauer, directors. The reports showed a large increase in the domestic and foreign business.

**U. S. Steel Corporation,** and subsidiary companies, Pittsburgh, Pa., proposes to have a comprehensive exhibit of its operations at the Panama Pacific Exposition in San Francisco, 1915. It will show the ore fields and operations in ore mining, rail and water transportation, dock operations, coal and coke and pig-iron production, and steel manufacture in its various lines. Moving pictures will illustrate the operations throughout all the departments, and examples of the social welfare work and safety devices installed at the plants will be shown.

**Acklin Stamping Co., 1645-1653 Dorr St., Toledo, Ohio,** has opened a branch office in the Ford Bldg., Detroit, Mich., under the management of W. C. Acklin, secretary of the company. The opening of the office was necessary to cover the extensive dealings with Detroit manufacturers. The company reports that its shipments during April were the largest in its history, and that the business

outlook for the coming season in the metal-stamping trade is unusually promising. Since May 1 it has booked a larger volume of business than in any similar length of time in its history.

**Smith-Booth-Usher Co., 228-238 Central Ave., Los Angeles, Cal.,** has been reorganized and the following officers have been elected: H. P. Usher, president and managing director; J. R. Hoffman, vice-president; F. P. Duncklee, treasurer; J. A. Nickell, secretary; L. M. Shockley, assistant secretary; E. H. Breidenbach, general manager of sale. The company's business will be conducted as heretofore, covering pumps, engines and water supply goods; steam boilers and power plant equipment; pipes, fittings, valves and mill supplies; transmission, shafting, belting; machine tools and woodworking machinery.

**Burroughs Adding Machine Co., Detroit, Mich.,** recently held a meeting of its Safety First Committee composed of assistant foremen of the company. Mr. A. Brain of the Factory Executive Committee gave an interesting and instructive talk on the Safety First movement. He stated that the object of the company's safety organization is to prevent injury and accidents both in the factory and outside through the education of the employee to the necessity of doing his work in a safe manner. Safety equipment is provided by the company and it only remains for the workmen to make the proper use of it and form habits of care in working.

**American Metal Co., 522 Park Bldg., Pittsburgh, Pa.,** which has recently completed a new plant at Wilkesburg, Pa., has been conducting a number of tests to determine the efficiency of a bronze journal bearing composed of 65 per cent copper, 30 per cent lead and 5 per cent tin, treated in crucibles. These journals are solid bronze castings requiring no babbitted surfaces. In a test for the Baltimore & Ohio R. R. a 22-pound bearing was placed under the tender of a Pacific type locomotive. After the engine had run 51,000 miles an examination of the bearing was made and it was found that it had worn but 1/32 inch and had not become heated at any time. Other bearings on the tender were rebabbitted six times each, according to the shop superintendent in charge of the locomotive. Tests made at the Soho Works of the Jones & Laughlin Steel Co., Pittsburgh, Pa., showed that this bronze is also superior for mill purposes. The superintendent of the mill stated that the two brasses gave continuous service for four weeks, or twice as long as the ordinary phosphor-bronze bearing.

## Classified Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

### HELP WANTED

**WANTED.**—A man who can secure contracts for Metal Stampings and Hardware Specialties. FORT DEARBORN MFG. CO., Chicago, Ill.

**SEVERAL DRAFTSMEN WANTED.**—Applications solicited from men with either Ordnance, Mechanical or Mechanical-Electrical experience. State fully age, experience, education and wages expected. Address Box 640, care MACHINERY, 140 Lafayette St., New York.

**WANTED.—SALESMAN** traveling among lumber camps and mills, to sell on commission high grade and long established axe, in Carolinas, Louisiana, Arkansas, West Virginia, or Texas and Mississippi. Must be free to handle such added line. The axe is produced in one quality only, and for lumbermen especially. L. J. EDDY, care Bradford Butler, 141 Broadway, New York.

**WANTED.—ENGINEERING WRITER** of wide experience, to edit for the Lefax Data Boxes. Mechanical Engineer with some knowledge of electrical engineering preferred. Only first-class writers who have actually done this class of work will be considered. Please refer to books that can be found in libraries, or submit samples of work. Address STANDARD CORPORATION, Pennsylvania Building, Philadelphia, Pa.

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We wish growing men who have shop experience as a foundation, and whose study has been to increase the efficiency of the shop by means of the above branches. Automobile connection is not essential in all cases. All communications will be considered in strictest confidence. Address P. O. Box 839, Detroit, Michigan.

### SITUATIONS WANTED

**WANTED.—POSITION AS TRAVELING ERECTOR OF MACHINERY,** or shop foreman, by practical machinist now employed as manager of machine shop; wide experience; 37 years of age; willing to start at low salary where promotion may be rapid; references furnished; Southern territory preferred. Address Box 645, care MACHINERY, 140 Lafayette St., New York.

### FOR SALE

**BOOKS ABOUT ELEVATORS.**—Best published. W. A. MORSE, 19-21 Union Place, Yonkers, N. Y.

**GET A "LAST WORD."**—The Test Indicator Par Excellence. H. A. LOWE, 1374 E. 88th St., Cleveland, O.

**DISC CALCULATING CHARTS** for draftsmen and designers. CARPENTER DRAFTING CO., 49 Oakland Terrace, Hartford, Conn.

**WANTED.**—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say, "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic, valuable information, condensed in pocket size. Price postpaid, \$1.00 cloth; \$1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

**FOR SALE.**—One 6000-lb. Morgan Engineering Company's Double Stand Steam Hammer; 48" Stroke; in good condition, used only six months. One No. 5-B Wm. Greer Pressure Blower in good condition, used only six months. The hammer and blower are available for immediate shipment. Prices very attractive. THE CARNAHAN TIN PLATE & SHEET CO., Canton, O.

### CONTRACT WORK

**HARDENING, Carbonizing, Galvanizing.** C. U. SCOTT, Head of Wall St., Davenport, Iowa.

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### PATENTS

**PATENTS SECURED.**—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

**PATENTS.**—H. W. T. JENNER, patent attorney and mechanical expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. Trade-marks registered.

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### EMPLOYMENT AGENCIES

**ENGINEERS, SUPERINTENDENTS,** designers, draftsmen, production engineers, master mechanics, auditors and other high-grade men are invited to file their professional records with us for vacancies now open and in prospect. Only high-grade men whose records can stand investigation need apply. THE ENGINEERING AGENCY, Inc.—20th Year—Chicago.

**IF QUALIFIED FOR** executive, technical, mechanical, professional or administrative position carrying salary between \$2,500 and \$12,000, write undersigned counsel, through whom strictly confidential preliminaries will be negotiated for important appointments. Send address only for prefatory details. R. W. BIXBY, Lock Box 134-D7, Buffalo.

### MISCELLANEOUS

**LIVE SHOP AGENTS WANTED** to distribute our tools. WELLES CALIPER CO., Milwaukee, Wis.

**AGENTS IN EVERY SHOP WANTED** to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

**NOTICE MANUFACTURERS.**—The Ocala Iron Works, Ocala, Fla., will rebuild their machine shop and would like to have catalogues and prices on the following machinery: 40" and 72" Boring Mills, 5 Ft. Radial Drill, 12 inch, 18 inch, 24 inch, and 36 inch Lathes, Milling Machines, Shapers, Planers, Pipe Machines, Keyseating Machines, Bolt Cutters, Drill Presses, Emery Wheels and a full line of small machine shop tools.

**MANUFACTURING AMERICAN SPECIALTIES IN ENGLAND.**—Consulting Engineer with intimate knowledge of the class of labor and working conditions in the various districts in Great Britain, visiting United States, is open to consider proposals for manufacturing American engineering productions in England. Address full particulars to "Engineer," care of Wickes & Knight, Solicitors, Finsbury House, Blomfield Street, London, E. C.